CodeMaster XL+ (M1722B) Defibrillator/Monitor

Service Manual

Printed in USA
HP Part Number: M1722-91909
Print Date: May 16, 2000
Edition 6

Notice

About This Edition

Publication number M1722-91909
Edition 6
Printed in USA

Edition History

Edition 1, August 1992
Edition 2, October 1992
Edition 3, February 1993
Edition 4, November 1994
Edition 5, August 1996
Edition 6, May 16, 2000

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As with electronic equipment, **Radio Frequency** (RF) interference between the defibrillator and any existing RF transmitting or receiving equipment at the installation site, including electrosurgical equipment, should evaluated carefully and
any limitations noted before the equipment is placed in service

Monitoring during quiescent periods of electrosurgery is possible but electromagnetic interference generated by electrosurgical tools during operation is sufficient to mask cardiac signals. A momentary recovery period is required for the monitor to return to normal operation and will be longer if the diagnostic monitoring mode is used. Pads or electrodes should be placed as far from the surgical area as reasonable while still performing normal function to minimize the possibility of burns. Radio frequency generation from electrosurgical equipment and close proximity transmitters may seriously degrade performance of the CodeMaster XL+ defibrillator/monitor.

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Classified by Underwriters Laboratories, Inc. with respect to electrical shock, fire, and mechanical hazards only in accordance with UL 2601-1.

CAUTION

The manufacturer, importer and seller are responsible for the effects on safety, reliability and performance only if: assembly operations, extensions, re-adjustments, modifications or repair are carried out by persons authorized by them, and the electrical installation of the relevant room complies with all local regulations and the equipment is used in accordance with the instructions for use. Use of accessories other than those recommended by Hewlett-Packard may compromise product performance.

THIS PRODUCT IS NOT INTENDED FOR HOME USE.

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the electrical installation of the relevant room or vehicle complies with the IEC or national requirements, and

the instrument is used according to the instructions for use presented in this manual.

Safety Summary

Safety Symbols Marked on the Defibrillator

The following symbols are used on the defibrillator.

On (Do not confuse with 1 Joule)

Off (Standby)

On/Off

Ground

Shock hazard

Caution - See operating instructions

Meets IEC type BF leakage current requirements and is defibrillator protected.

Meets IEC type CF leakage current requirements and is defibrillator protected.

Equipotential (rear of unit, adjacent to AC input)

Protective earth (ground)

Please see Chapter 3, **Performance Verification and Maintenance**, for safety requirements that apply to the defibrillator.

Conventions Used in This Manual

WARNING

Warning statements describe conditions or actions that can result in personal injury or loss of life.

CAUTION

Caution statements describe conditions or actions that can result in damage to the equipment or software.

NOTE

Notes contain additional information on defibrillator usage.

TEXT represents the messages that appear on the display.

key represents keys on the front panel.

LIGHT represents lighted indicators on the key panel.

Preface

This manual contains service information for the HP M1722B CodeMaster XL+ Defibrillator/Monitor. If you are servicing one of the following defibrillators:

- the M1722B (manufactured before June of 2000)
- the M1722A
- the M1723A/B

then you may use this guide with the understanding that:

- The model M1723A/B is equivalent to the M1722B (without option A01).
- The model M1722A/B is equivalent to the M1722B (with option A01).

This manual is organized as follows:

Chapter 1—Introduction. Contains a general description of the defibrillators, lists of technical specifications, and lists of options and accessories.

Chapter 2—Setup and Configuration. Summarizes the defibrillator installation and explains how to configure the defibrillator for specific customer requirements.

Chapter 3—Performance Verification and Maintenance. Explains how to inspect, test, and verify the defibrillator's performance using built-in tests, and lists maintenance procedures and safety requirements that apply to the defibrillator.

Chapter 4—Troubleshooting. Contains procedures and error codes to aid the service person in localizing faults to a replaceable subassembly.

Chapter 5—Removal and Replacement. Contains procedures for removing and replacing each of the defibrillator's major subassemblies.

Chapter 6—Parts Lists. Lists part numbers for the defibrillator's replaceable parts, and provides assembly drawings.

Chapter 7—Theory of Operation. Provides an overview of how the defibrillator works and describes the operation of the major subassemblies.

Appendix A—Appendix A Connector Pin Assignments. Identifies and defines the signals assigned to the subassembly interconnections.

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Introduction

This chapter introduces the CodeMaster XL+ M1722B Defibrillator/Monitor and lists the technical specifications.

WARNING

Dangerous voltages capable of causing injury or death are present at the paddles or patient cables during normal operation. This defibrillator is to be used and serviced only by qualified personnel.

CAUTION

Operation of this device in the vicinity of high-powered transmitters or electrosurgical instruments may result in interference of the ECG display.

NOTE

Safe and effective use of medical instrumentation requires periodic inspection and preventive maintenance. Perform the preventive maintenance procedures in Chapter 3, **Performance Verification and Maintenance**, of this manual at the required intervals to ensure satisfactory instrument performance.

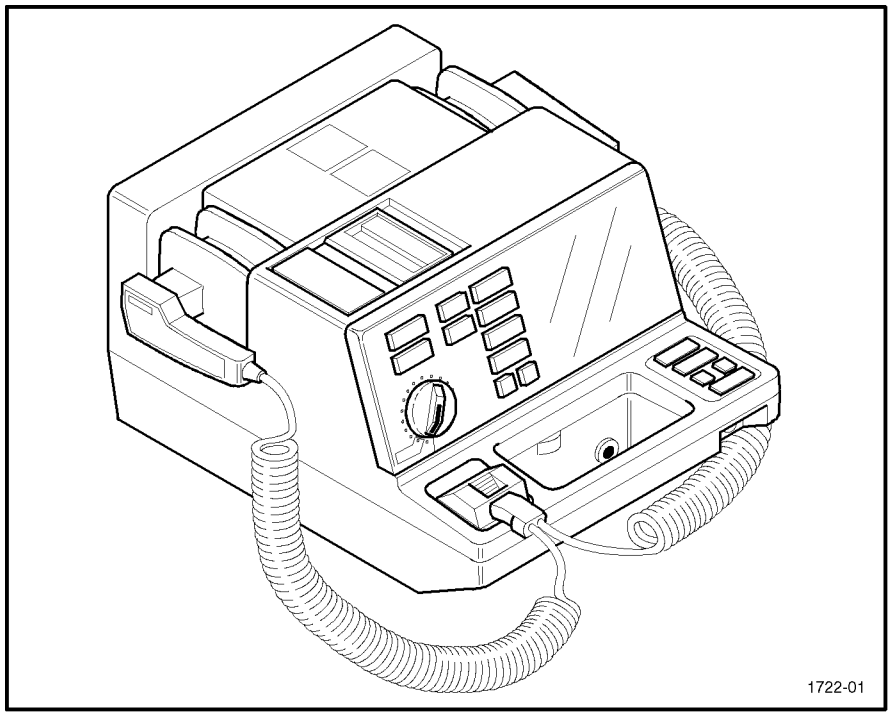
The CodeMaster XL+ Defibrillator/Monitor

This instrument is a portable defibrillator/monitor powered by internal battery or AC power. It combines a 360-joule defibrillator, ECG monitor, and annotating strip chart recorder in a compact, light-weight package. Instrument features include crisis-oriented controls, fast charge, a real-time clock, interchangeable paddles, and automatic documentation of events. The monitor includes a 5-inch screen which displays the ECG, selected ECG source, heart rate, and messages and alerts. A microprocessor-based system rejects noise and artifact, and automatically stabilizes and restores baseline.

In addition, the XL+ Option A01 has adjustable heart rate alarms, patient contact indicator (PCI), recorder event marker, complete recorder annotation, event summary, and 3- and 5-wire patient cable ECG capability. Oxygen saturation measurement (SPO_2) is available as an option. Transcutaneous external pacing is also available as an option or field upgrade for the XL+. The optional 12-pin ECG input connector is compatible with the ECG patient cable. The XL+ can interface to the HP Central Station via an analog-only high-level ECG Out signal. Figure 1-1 shows the XL+ defibrillator.

The XL+ defibrillator fits onto the MTRO-OO336L cart. The cart features three drawers (with a latch/lock system) for storing suction pumps and other resuscitation equipment.

Figure 1-1



CodeMaster XL+ Defibrillator/Monitor

The defibrillator is designed for long-term reliability. The modular design makes extensive use of VLSI and gate-array technology. The modular approach means less downtime for the user, due to the quick field repair times inherent in the subassembly replacement philosophy of repair. The built-in menu-driven tests efficiently aid in identifying faulty operation, further speeding the repair process.

MTRO-00336L Cart

The MTRO-00336L Cart provides mobility for the CodeMaster defibrillator. The cart shell and drawers are constructed of a durable light-weight polymer material that will not corrode, rust, or dent. Built-in hand grips and 5-inch non-marring casters (two with brakes) provide easy maneuverability. The cart surfaces are smooth and stain-resistant, with rounded corners. Drawers can be removed without tools for thorough cleaning.

Inquiries

For questions or comments regarding these instruments, contact the nearest Sales/Service Office or one of the Service Dispatch Centers. Always identify the instrument by model number and serial number in all correspondence. Sales and service offices are listed at the end of this manual. Toll-free numbers for Service Dispatch Centers are listed in Chapter 6, **Parts Lists**.

Specification Data

The following tables list the technical specifications for the defibrillator and the mobile cart.

Table 1-1 **Physical Specifications**

Parameter	Specification
Dimensions (l × w × h)	
defibrillator:	15.75" × 12.75" × 8.0" (40.05 cm × 32.39 cm × 20.32 cm)
cart:	22" × 34" × 34.5" (55.9 cm × 86.3 cm × 87.6 cm)
Weight	
defibrillator:	24 lbs. (10 kg) (includes external paddles, battery, and recorder paper.)
cart:	82 lbs. (37 kg)
Chemical resistance, cleaners:	Withstands the following: isopropyl alcohol (except leadwires and patient cable), mild soap and water, chlorine bleach and water (30 ml/l of water).

CAUTION

The main battery will be damaged if stored for extended periods at a temperature greater than 50° C.

Table 1-2 **Environmental Specifications**

Parameter	Specification
Temperature	
operating:	0° to 55° C (32° to 131° F)[1]
storage:	–20° to 70° C (–4° to 158° F)[1]

Table 1-2 Environmental Specifications

Parameter	Specification
Humidity	
operating:	15 to 95% RH, non-condensing
storage:	15 to 95% RH, non-condensing
Pressure (altitude)	
operating:	To 15,000 ft. (4600 m)
storage:	To 15,000 ft. (4600 m)

[1]Battery must be removed below 0° C (32° F) and above 45° C (113° F).

Table 1-3 Electrical Specifications

Parameter	Specification
Defibrillator	
Output energy (delivered):	2, 3, 5J (±1J)
	7, 10J (±2J)
	20, 30J (±4J)
	50, 70, 100, 150, 200, 300, and 360J (±15%)
Waveform:	Damped sinusoidal (Lown).
Charge control:	Push-button on apex paddle and on front panel.
Charge time (Battery operation):	Less than 5 seconds to 360 joules.
Armed indicators:	Charge done tone, charge done lamp on apex paddle, and available energy indicated on display.
Paddle contact indicator (PCI): (Option A01)	3-color LED bar graph array on STERNUM paddle indicates quality of defibrillator paddle contact before discharge.
Paddles:	Standard paddles are anterior/anterior, adult and pediatric. Adult electrodes (83 cm sq) slide off to expose pediatric electrodes (21 cm sq). Paddle cord is 10 ft (3m). Full range of internal paddles are available.
Synchronizer:	SYNC message appears on monitor and is annotated periodically on recorder while in synchronous mode. An audible beep sounds with each detected R- wave, while a marker on the monitor and sync designator on the recorder strip indicate the discharge point.
Monitor	
Inputs:	ECG may be viewed through paddles or patient cable. Lead I, II, III, or PADDLES selectable. Additional leads (avR, avF, AvL, V Leads) and PADS are available (Option A01). Monitor and recorder indicate selected ECG source.
Lead fault:	LEADS OFF message and dashed baseline appear on monitor if a lead becomes disconnected.

Table 1-3 Electrical Specifications (Continued)

Parameter	Specification
Common mode rejection:	Leads: ≥100 dB and Paddles: ≥90 dB measured as per AAMI standards for cardiac monitors (EC13).
Pace pulse rejection:	The pace pulse rejection algorithm of this product meets the requirements of Section 3.1.4.1 (Pacemaker Pulse Rejection Without Over/Undershoot) of AAMI EC13 - 1983 (Cardiac Monitors, Heart Rate Meters and Alarms). This product will not reject pace pulses as described in Section 3.1.4.2 (Pacemaker Pulse Rejection With Over/Undershoot) of the same document.
Display size and type:	5 inch diagonal (12.7 cm) CRT for 4 seconds of ECG data on screen; non-fade, fixed trace. Scrolling trace is selectable.
Sweep speed:	25 mm/sec nominal.
Frequency response:	0.5 to 40 Hz.
Heart rate display:	Digital readout on monitor from 15 to 350 BPM.
Heart rate alarms:	Three pairs of high and low heart rate alarm limits from 20 to 280 BPM. On Option A01, limits are configurable.
ECG output:	1 V/mV.
Patient cable length:	10 ft.
Thermal Array Recorder	
Event summary: (Option A01)	Stores and prints 3 seconds of pre-critical event data, and 8 seconds of post-critical event data for up to 28 events. Data is retained after unit is turned off.
Annotates:	Time, date, HR, ECG mode, event marker, defibrillator mode, and selected energy. Additionally, on XL+, actual delivered energy, peak current, and patient impedance.
Speed:	25 mm/sec.
Paper size:	50 mm by 30 m (100 ft).
Recorder mode:	May be configured to automatically document events and ECG during defibrillation episodes. The recorder can be configured to run in either real time or with a 6 second delay.
Frequency response:	0.5 to 40 Hz. Additionally, on Option A01, 0.05–150 Hz selectable.

Table 1-4 Power and Battery Specifications

Parameter	Specification
AC Line Power	
Line frequency:	50 and 60 Hz.
Line voltage:	100–230 V AC ±15%.
Battery	
Type:	Rechargeable sealed lead-acid. 4 Ah, 12 V nominal.

Table 1-4 Power and Battery Specifications

Parameter	Specification
Charge time:	Approximately 2 hours to 90% of full capacity. 18 hours to 100% capacity. Repeated charging to less than 100% will reduce useful life of battery.
Capacity:	Approximately 2.5 hours of monitoring, or 50 full-energy discharges, or 1 hour of monitoring and recording.
Indicators:	Illuminated LED indicates battery is charging. LOW BATTERY message appears on monitor when limited battery capacity remains.

Table 1-5 External Pacer (Optional)

Parameter	Specification
Current pulse amplitude:	10 mA to 200 mA.
Pulse width:	20 msec.
Rate:	40 ppm to 180 ppm.
Modes:	Demand or fixed rate.
Refractory period:	40 to ≤80 ppm: 340 msec ± 10%; > 80 to 180 ppm: 240 msec ± 10%.

Table 1-6 SpO_2 Monitor (Optional)

Parameter	Specification
SpO_2 measurement	Range: 0 to 100% Accuracy with HP 1190A transducer: 1 standard deviation. 65% to 80%: ±2.5% 80% to 100%: ±1.5% Accuracy with Nellcor N-25, I-20, D-20, D-25, Oxiband A/N, Oxiband P/I sensors: 1 standard deviation. 80% to 100%: ±3%
Pulse rate measurement	Range: 30 to 300 bpm. Accuracy: ±1% Resolution: 1bpm
Averaging	SpO_2 and pulse rate: averaged over eight beats.
SpO_2 alarm limits	Three preset limits: 100/90, 100/85, and 100/80. Default is alarms off.
Time to alarm	Alarm within 10 seconds of SpO_2 value dropping below alarm setting.
Time to valid numeric	Valid 15 seconds after power on.
Recovery after defibrillation	Valid numeric 15 seconds after a discharge

Table 1-6 **SpO_2 Monitor (Optional)**

Parameter	Specification
INOP alerts	Warning messages for: SpO_2 cable off noisy signal low signal light interference
Pulse amplitude indicator	Indicates pulsatile activity.

Table 1-7 **Shock Advisory (Optional)**

Parameter	Specifications
Analysis Time	seven to ten seconds
Output Energy (Delivered)	Factory default protocol 200J, 200J, 360J
Analysis Control	Push-button on front panel
Charge Time	Less than 5 seconds to 360 joules with battery present. Less than 15 seconds to 360 joules to AC only.
Armed Indicators	Charge done tone and available energy indicated on display
Advisory Event Summary	Stores approximately 200 events and 50 ECG strips. Data retained after instrument turned off.
Waveform:	Damped sinusoidal (Lown)

Options and Accessories

CodeMaster XL+ Defibrillator/Monitor

These tables list the options and accessories available for the XL+ defibrillator/monitor.

Country Options

Each country option includes appropriate power cord, and language. Table 1-8 shows the configuration of each country option.

Table 1-8 Country Option Configurations

Option	Country	Labels	Users Manuals[1]	Voltage[2]	Frequency[2]	Power Cord[3]
ABA	North America	English	English	120	60	903-US, NEMA 5-15
ABB	Europe	English	English	220	50	902-EURO, IEC 83
ABC	Canada	French	French	120	60	903-US, NEMA 5-15
ABD	Germany	German	German	230	50	902-EURO, IEC 83
ABE	Spain	Spanish	Spanish	230	50	902-EURO, IEC 83
ABF	France	French	French	230	50	902-EURO, IEC 83
ABG	Australia	English	English	240	50	901-Australia
ABH	Netherlands	Dutch	Dutch	230	50	902-EURO, IEC 83
ABJ	Japan	Japanese	Japanese	100	50	903-US, NEMA 5-15
ABK	Intercon English	English	English	220	50	902-EURO, IEC 83
ABL	Canada	English	English	120	60	903-US, NEMA 5-15
ABM	Latin America	Spanish	Spanish	120	60	903-US, NEMA 5-15
ABN	Norway	Norwegian	Norwegian	220	50	902-EURO, IEC 83
ABP	Switzerland	German	German	230	50	906-Swiss
ABQ	Switzerland	French	French	230	50	906-Swiss
ABS	Sweden	Swedish	Swedish	230	50	902-EURO, IEC 83
ABU	United Kingdom	English	English	240	50	900-UK, BS 1363 A
ABX	Finland	Finnish	Finnish	230	50	902-EURO, IEC 83
ABY	Denmark	Danish	Danish	230	50	912-Danish
ABZ	Italy	Italian	Italian	230	50	902-EURO, IEC 83
ACD	Switzerland	English	English	230	50	906-Swiss
ACQ	South Africa	English	English	240	50	917-EURO, IEC 83
ACS	Europe	French	French	220	50	902-EURO, IEC 83
AKL	Thailand	English	English	220	50	903-ULS, NEMA 5-15
AKM	China	English	English	220	50	901-China
AKV	South America	Spanish	Spanish	220	50	902-EURO, IEC 83
A1V	Korea	English	English	220	60	902-EURO, IEC 83

Table 1-8 Country Option Configurations (Continued)

Option	Country	Labels	Users Manuals[1]	Voltage[2]	Frequency[2]	Power Cord[3]
AB4	Singapore	English	English	220	50	900, BS 1363 A
AB5	Hong Kong	English	English	220	50	900, BS 1363 A
ABW	Belgium	Dutch	Dutch	230	50	902-EURO, IEC 83
AC8	Argentina	Spanish	Spanish	220	50	920 ARG. Res 63
ABW	Belgium	French	French	230	50	902-EURO, IEC 83
ACJ	India	English	English	240	50	917 BS 546 (15A)
ACM	Belgium	German	German	230	50	902-EURO, IEC 83
ACP	Austria	German	German	230	50	902-EURO, IEC 8
AKH	Chile	Spanish	Spanish	220	50	921 CEI 23 - 16
AKJ	Israel	English	English	220	50	919 SI 32
AKY	Peru	Spanish	Spanish	220	60	904 UL 1681
AR6	Indonesia	English	English	220	60	902-EURO, IEC 8
AWB	Greenland	English	English	220	50	912 SR 107 2 D1
AWC	Laos	French	French	220	50	903 UL 1681
AWD	Paraguay	Spanish	Spanish	220	50	902-EURO, IEC 8
AWN	Lybia	English	English	240	50	902-EURO, IEC 83

[1]See Table 1-9 and Table 1-10 for part numbers.

[2]CodeMaster AC input: 100 to 230 VAC, ±15%, 50 to 60 Hz.

[3]See Table 1-10 for part numbers.

Table 1-9 Codemaster XL+ (M1722B) Documentation Part Numbers

Country	User Guide Part Number	User Card Part Number	Pacer Card Part Number	Checkcard Part Number	SpO_2 Concept Guide	SpO_2 Sensor Guide
English	M1722-94980	M1722-92908	M1722-93900	M1722-93920	M1722-93950	M1722-93970
French	M1722-94981	M1722-92918	M1722-93901	M1722-93921	M1722-93951	M1722-93971
German	M1722-94982	M1722-92928	M1722-93902	M1722-93922	M1722-93952	M1722-93972
Dutch	M1722-92983	M1722-92938	M1722-93903	M1722-93923	M1722-93953	M1722-93973
Spanish	M1722-94984	M1722-92948	M1722-93904	M1722-93924	M1722-93954	M1722-93974
Italian	M1722-94985	M1722-92958	M1722-93905	M1722-93925	M1722-93955	M1722-93975
Swedish	M1722-94986	M1722-92968	M1722-93906	M1722-93926	M1722-93956	M1722-93976

Table 1-9 Codemaster XL+ (M1722B) Documentation Part Numbers

Country	User Guide Part Number	User Card Part Number	Pacer Card Part Number	Checkcard Part Number	SpO_2 Concept Guide	SpO_2 Sensor Guide
Japanese	M1722-94987	M1722-92978	M1722-93907	M1722-93927	M1722-93957	M1722-93977
Norwegian	M1722-94988	M1722-92919	M1722-93908	M1722-93928	M1722-93958	M1722-93978
Finnish	M1722-94989	M1722-92920	M1722-93909	M1722-93929	M1722-93959	M1722-93979
Danish	M1722-94990	M1722-92921	M1722-93910	M1722-93930	M1722-93960	M1722-93980

Table 1-10 CodeMaster XL+ (M1722B) Shock Advisory Documentation

Country	User's Guide Part Number	Concept Guide Part Number
English	M1722-94960	M1722-94940
French	M1722-94961	M1722-94941
German	M1722-94962	M1722-94942
Dutch	M1722-94963	M1722-94943
Spanish	M1722-94964	M1722-94944
Italian	M1722-94965	M1722-94945
Swedish	M1722-94966	M1722-94946
Japanese	M1722-94967	M1722-94947
Norwegian	M1722-94968	M1722-94948
Finnish	M1722-94969	M1722-94949
Danish	M1722-94970	M1722-94950

Table 1-11 Power Cord Part Numbers

Power Cord Key	HP Part Number
900	8120-1351
901	8120-1369
902	8120-1689
903	8120-1378
906	8120-2104
912	8120-3997
917	8120-4211

Pacing Option—A01 Plus Package
- Paddle set with PCI
- 5-Lead ECG capability
- Configurable heart rate alarms
- Event review

C02 Option

Add Pacing

SpO_2 Option

C62	Add SpO_2
C73	SpO_2 adult finger tip sensor, reusable (M1190A)
C74	Adaptor cable for Nellcor sensors (M1900B)

Paddles and Pad Options

C13	Delete Standard Ant/Ant Paddles
C14	Add Internal Paddle Adapter Cable
C15	Add 7.5 cm Internal Paddles (switchless)
C16	Add 6.0 cm Internal Paddles (switchless)
C17	Add 4.5 cm Internal Paddles (switchless)
C18	Add 2.8 cm Internal Paddles (switchless)
C20	Add Adhesive Pads Adapter
C21	Add Adhesive Pads
C24	Add Sterilizable External Paddle Set
C25	Add Paddle Contact Indicator (PCI)
C26	Add 7.5 cm Internal Paddles (switched)
C27	Add 6.0 cm Internal Paddles (switched)
C28	Add 4.5 cm Internal Paddles (switched)
C29	Add 2.8 cm Internal Paddles (switched)

ECG Cable/Connector Options

C30	Substitute 6-pin AAMI ECG connector; includes 6-pin 3-wire AHA cable
C31	Substitute 6-pin AAMI ECG connector; includes 6-pin 5-wire AHA cable (Option A01 only)
C32	Substitute 12-pin HP CMS ECG connector; includes 12-pin 3-wire AHA cable
C33	Substitute 12-pin HP CMS ECG connector; includes 12-pin 5-wire AHA cable (Option A01 only)
C34	Substitute 12-pin HP CMS ECG connector; includes 12-pin 3-wire IEC cable
C35	Substitute 12-pin HP CMS ECG connector; includes 12-pin 5-wire IEC cable (Option A01 only)
C36	Substitute 8-pin 5-wire AHA ECG cable (Option A01 only)
C37	Substitute 8-pin 5-wire IEC ECG cable (Option A01 only)

Defibrillator Case Color

048	Parchment White
049	High Visibility Yellow

Hardware Options

C50	Add Swivel Wall-Mount Hardware
C51	Add Carrying Case
C52	Add Accessory Pouch

Shock Advisory Option

C80	Add Shock Advisory

Multifunction Electrodes

C81	Multifunction Pediatric Defibrillator Electrode
C82	Multifunction Adult Defibrillator Electrode

Upgrade Program

085	Defibrillator Upgrade Program

Sync Cable Options

J01	Add 8-pin Sync Cable
J02	Add 6-pin AAMI Sync Cable
J03	Add 12-pin HP CMS Sync Cable

Documentation Options

0B3	Service Manual (English only)
0BP	In-Service Training Video (VHS-NTSC)
0BQ	In-Service Training Video (VHS-PAL)
0BR	Service Training Video (VHS-NTSC)
0BS	Service Training Video (VHS-PAL)

Standard Accessories Supplied

- *CodeMaster XL+ Users Guide* (M1722A/B and M1723A/B)
- *CodeMaster XL+ Series Quick Reference Card* (M1722A/B and M1723A/B)
- ECG Patient Cable (language/country specific)—M1733A/M1735A
- Disposable Electrodes—HP 14445C
- 1 roll, Thermal Paper—HP 40457C

Cart

MTRO-00336L	Add Cart

Warranty

W07	5 years warranty on-site

Setup and Configuration

Introduction

This chapter covers setting up and configuring the CodeMaster XL+ Defibrillator/ Monitor. If you are a Hewlett-Packard service representative, this information provides a factory-recommended process to use when assisting customers. The configuration information guides you through the setup menus, and describes configuration choices.

Setup

The defibrillator is ready for operation when the following tasks have been properly performed:

- Install battery.
- Charge battery (for 24 hours).
- Install paper.
- Make sure that the paddle set connector is seated and locked.
- Select configuration settings; set date and time.

Line Voltage Settings

The defibrillator automatically adjusts to the line voltage that is supplied (from 100–230 VAC ±15% at 50/60 Hz). No manual setting or adjustment is required.

Installing and Charging the Battery

This procedure describes installing the battery for the first time. To replace a battery, refer to the battery replacement procedure in Chapter 5, **Removal and Replacement**.

NOTE

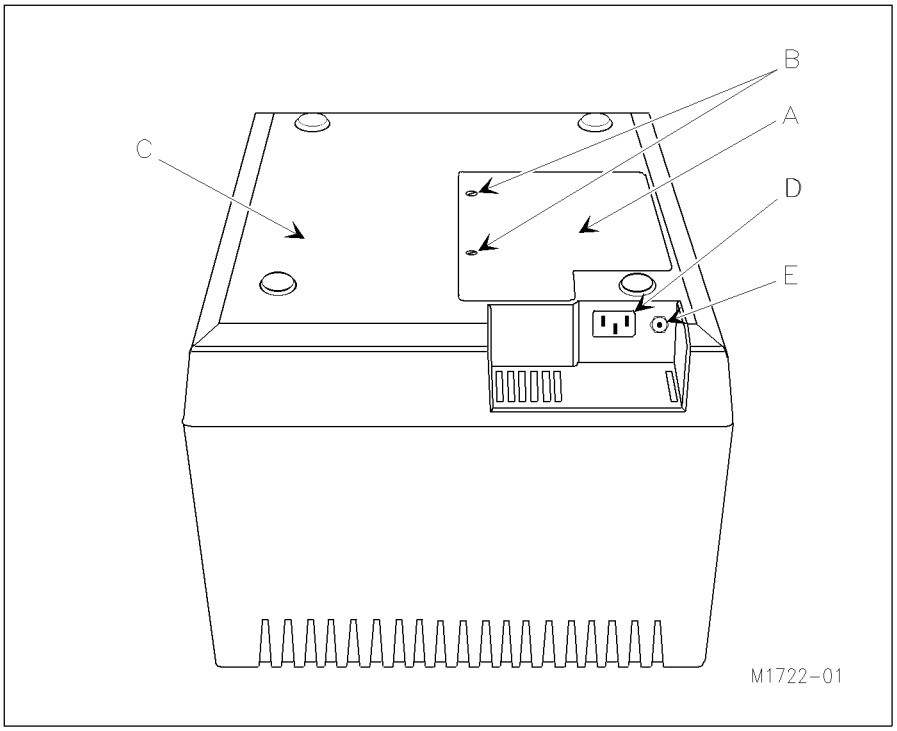
The defibrillator operates from either battery or AC power.

Use only HP battery assembly M1758A. The use of a non-HP recommended battery, may induce a problem and void the product warranty.

WARNING

To avoid the possibility of hazardous electrical shock, unplug the instrument from the AC power source before installing or replacing the battery.

Figure 2-1



Accessing the Battery Compartment

A Battery compartment door.

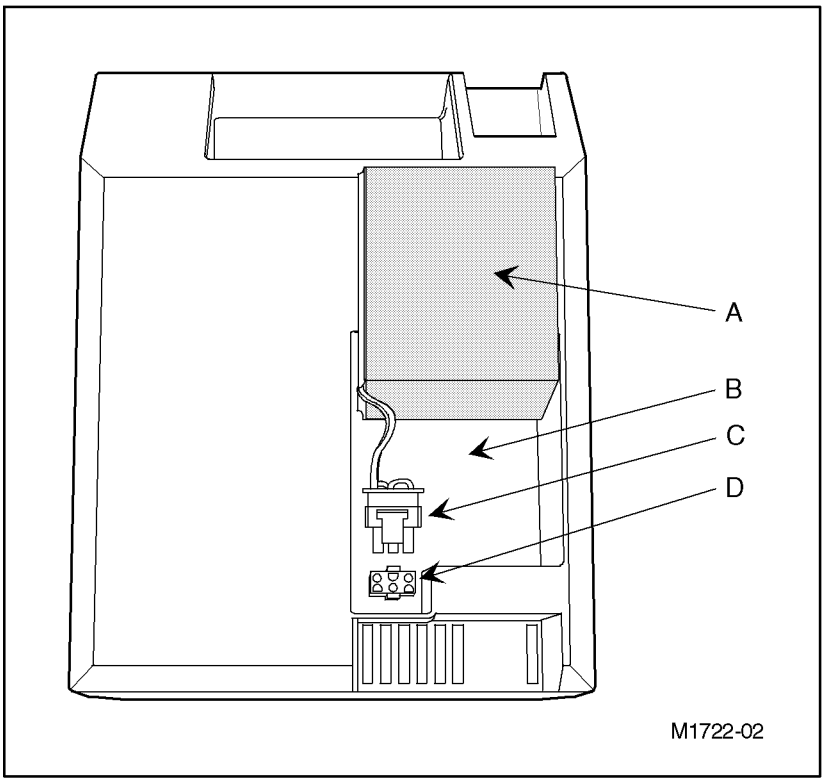
B Retaining screws ($\frac{1}{4}$ turn).

C Bottom side of defibrillator.

D AC power receptacle.

E Equipotential connector.

Figure 2-2



Installing the Battery

A Battery.

B Battery compartment.

C Battery plug.

D Battery connector.

To install the battery:

1 Turn the instrument upside down.

2 Open the defibrillator battery compartment by turning the two $\frac{1}{4}$-turn screws on the battery door $\frac{1}{4}$ turn counter clockwise (as shown in Figure 2-1); then, lift off the battery door.

3 Align the polarized battery plug with the battery connector located inside the battery compartment (as shown in Figure 2-2). Be sure to match the keying.

4 Push the plug into the connector until the plug is locked.

5 Gently lower the battery into the battery compartment until completely seated.

6 Route the battery cable between the battery and the compartment wall, so the cable will not be caught between the compartment door and the case.

7 Replace the battery door and secure it by turning the two retaining screws $\frac{1}{4}$ turn, clockwise.

8 Turn the instrument right side up.

9 Connect the power cord to the defibrillator, then plug the cord into an AC outlet. The green (AC POWER) and (BATT CHRG) indicators on the front panel should light up. (The (AC POWER) indicator lights when the instrument is plugged into AC power; the (BATT CHRG) indicator is on when the battery is installed *and* the instrument is plugged into AC power.)

NOTE

To ensure full battery capacity, charge the battery for 24 hours following its installation in the defibrillator.

CAUTION

If the defibrillator will be stored for longer than one month without AC power, remove the battery from the unit. Note on the instrument that the battery has been removed. After an extended storage period, the battery should be tested using the battery capacity check. See Chapter 3, **Performance Verification and Maintenance**.

Loading the Recorder Paper

The defibrillator recorder uses two-inch wide, thermal paper (40457C/D). To load the paper:

1 Slide the recorder door toward the right side of the defibrillator until the paper platen tilts up.

2 Pull up on the plastic removal tag to remove the old paper roll, if one is present.

3 Unroll about six inches of paper on the new roll; turn the paper roll so that the grid side of the unrolled paper is on the bottom (facing downward).

4 Place the roll of thermal paper in the recorder so that the grid side of the paper will face the print head in the recorder.

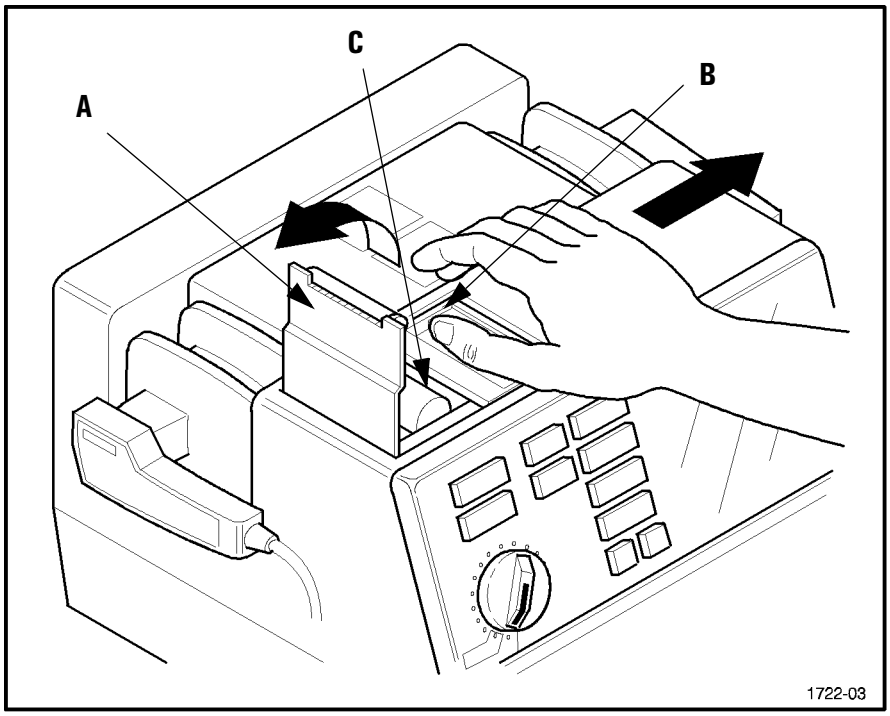
5 Pull the free end of the paper upward and over the recorder platen. (See Figure 2-3).

6 While holding the recorder door open (to the right), press the platen down to its normal (closed) position.

7 Release the recorder door, allowing it to close over the platen.

8 Place the free end of the paper on the left side of the recorder. The grid side should be visible (facing up).

Figure 2-3



Loading the Paper

A Recorder Door.

B Paper Platen.

C Paper.

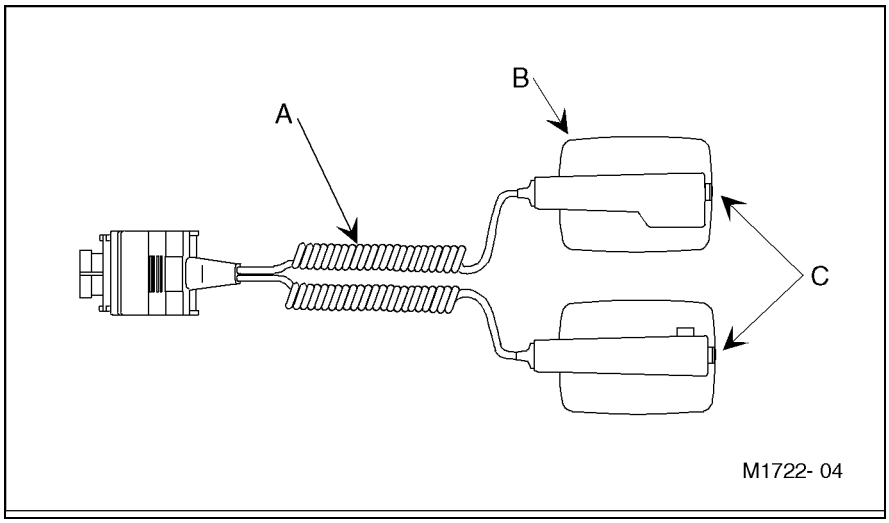
Connecting Paddles, Patient Cables and SpO_2 sensors

The defibrillator has a paddles connector (defibrillator connector) for attaching pads/ paddles sets and the ECG Input connector for attaching leads. It also has an optional SpO_2 connector for attaching SpO_2 sensors.

Defibrillator Connector

The defibrillator connector accepts external paddles, external adhesive pads, or internal paddles. The next three figures show these paddles and pads.

Figure 2-4



External Paddle Set

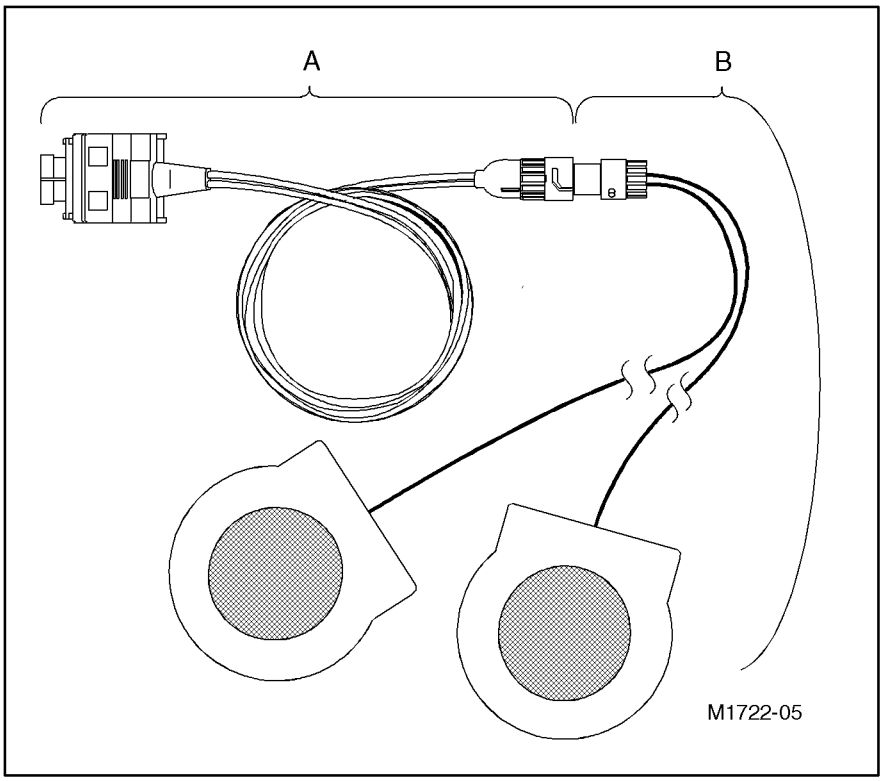
A Adult/Pediatric Anterior/Anterior paddle set. (M1746A/B, M1747A/B)

B Standard external (adult) paddle. (M1746-62802)

C Adult adaptor release latch.

The standard external paddles set also includes pediatric paddles. To expose the pediatric paddle set, depress the release latch at the front of a paddle while pulling forward on the adult paddle surface. This will remove the adult paddle contact surface and uncover the smaller pediatric contact surface.

Figure 2-5

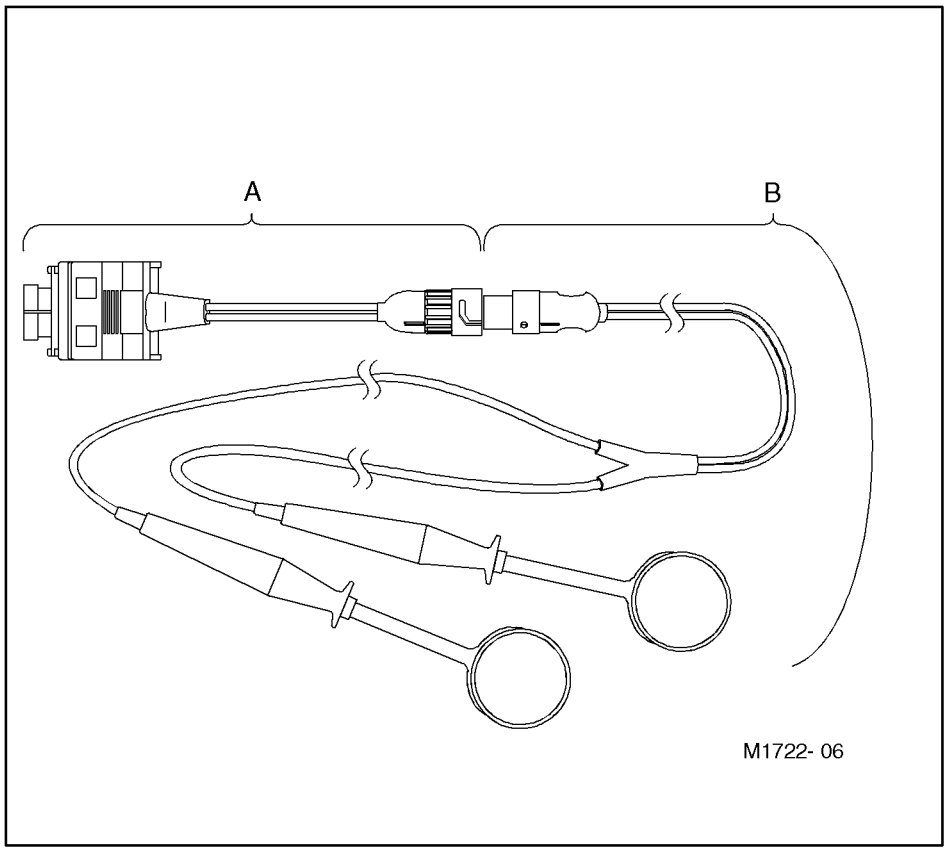


Pads Adapter Cable and External Adhesive Pads

A Pads adapter cable—9 ft. in length (HP M1750A/B). This cable is not compatible with the internal paddles set shown in Figure 2-6.

B External adhesive pads.
M3501A - adult AAMI
M3502A - adult IEC
M3503A - pediatric IEC
M3504A - pediatric AAMI

Figure 2-6



Internal Paddles

A Internal paddles adapter cable—1 ft. in length. (M1740A/B)

B Internal paddle set.
(M1741A)
(M1742A)
(M1743A)
(M1744A)

Table 2-1 lists the paddles sets, adapter cables, and their part numbers.

Table 2-1 **Paddles/Pads Sets, Adapter Cables for Defibrillator Connector**

Description	P/N[1]	Application[2]
EXTERNAL PADDLES:		D, S, M
Integrated cable/paddles set (Standard with instrument)		
CodeMaster XL+ (with PCI), Option A01:	M1746A/B	
CodeMaster XL+ (without PCI):	M1747A/B	
INTERNAL PADDLES		D
Internal paddles adapter cable:	M1740A/B	
Switchless internal paddle set		
7.5 cm:	M1741A	
6.0 cm:	M1742A	
4.5 cm:	M1743A	
2.8 cm:	M1744A	
Switched internal paddle set		
7.5 cm:	M1784A	
6.0 cm:	M1785A	
4.5 cm:	M1786A	
2.8 cm:	M1787A	
EXTERNAL ADHESIVE PADS		D, S, M, P
Pads adapter cable:	M1750A/B	
Adult multifunction pads (AAMI):	M3501A	
Adult multifunction pads (IEC):	M3502A	
Pediatric multifunction pads (IEC);	M3503A	
Pediatric multifunction pads (AAMI);	M3504A	

[1]Parts numbered with an **A** and **B** suffix are identical except that a part ordered has a different colored connector.
A. Parchment White
B. Yellow

[2]Application key: D = Defibrillation, S = Synchronized cardioversion, M = Monitoring, P = Pacing.

You may configure the instrument to make PADDLES (PADS) the default monitoring source at power-on. This choice is available in setup menu 2. See “Configuration” on page 2-16.

Connecting Paddles or Pads. To connect external paddles, internal paddles, or adhesive pads to the defibrillator, perform the following steps:

1 Slide the paddle connector lock on the paddles plug to the **unlock** position. To do this, push the lock in the direction shown by the arrow in Figure 2-7.

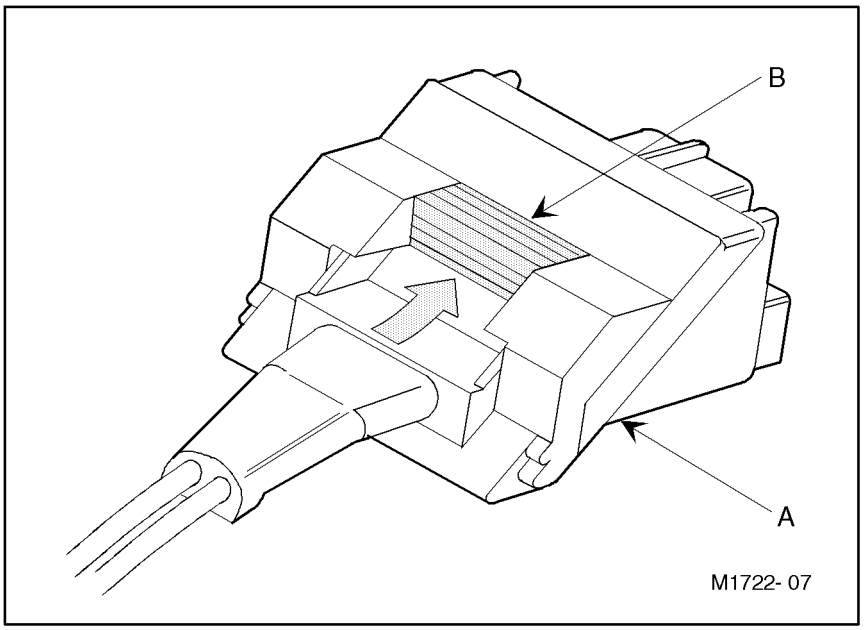
2 Insert the paddles/pads adapter cable plug into the paddles connector on the defibrillator, as shown in Figure 2-8.

CAUTION

Do not insert the plug into the connector without unlocking the connector lock (see step 1). If you do not unlock the connector lock before inserting the plug, the locking mechanism may be disengaged.

3 Slide the paddle connector lock to the **lock** position, to latch the plug in place.

Figure 2-7

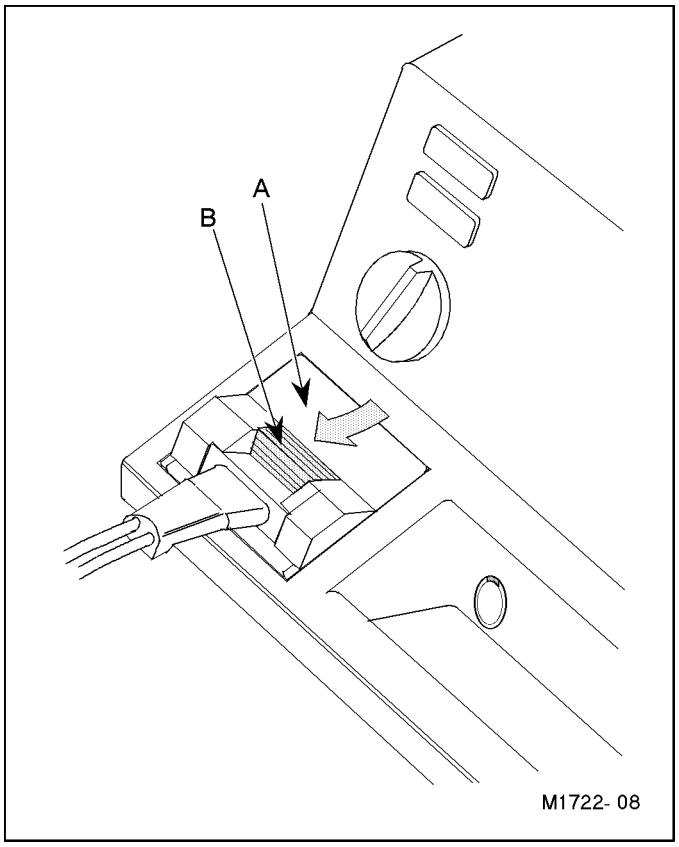


Opening Lock

A Paddles Plug.

B Connector Lock. Push the lock in the direction indicated by the arrow to move the lock to the **unlock** position (shown).

Figure 2-8



Connecting External Paddles, Internal Paddles, or PAD adapter Cable

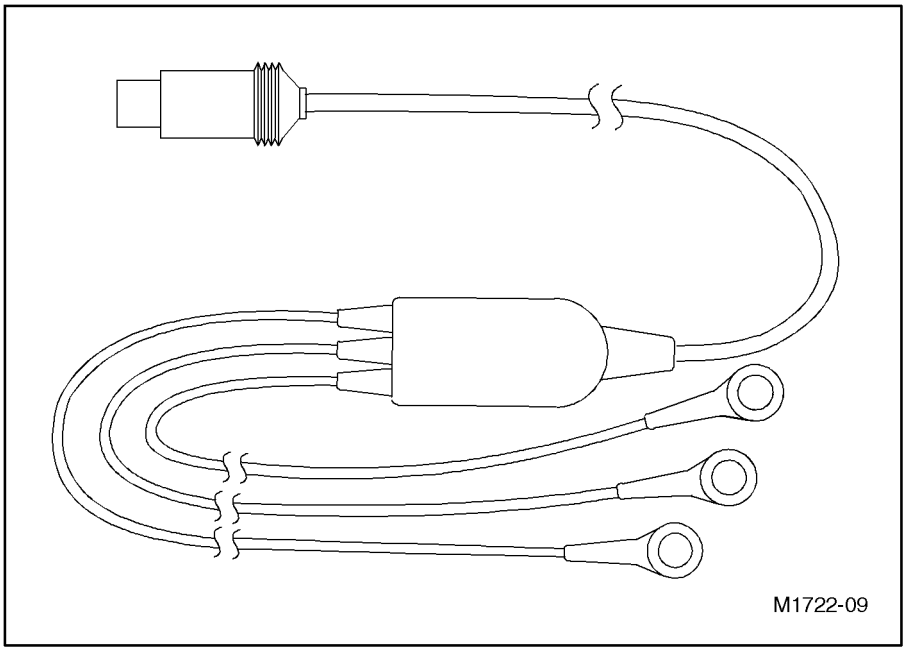
A Paddles Plug in Paddles Connector.

B Connector Lock. Push the lock in the direction indicated by the arrow to move the lock to the **lock** position (shown).

ECG Input Connector

The ECG Input connector on the defibrillator is a 6-, 8-, or 12-pin connector, depending on the option purchased with the instrument. For each connector option, several different patient cables can be used for various ECG sources and applications. Figure 2-9 shows an example of a patient cable.

Figure 2-9



An ECG Patient Cable

Table 2-2 lists available patient cables and lead sets, and their part numbers.

Table 2-2 **Patient Cables and Lead Sets**

Patient Cables, Leads, Lead Sets	Part Number
6-Pin Patient Cables (AHA only)	
3-wire	M1731A
5-wire	M1732A
8-Pin Patient Cables	
AHA 3-wire	M1733A
AHA 5-wire	M1734A
IEC 3-wire	M1735A
IEC 5-wire	M1736A
12-Pin Patient Cables (a trunk cable and a matching lead set)	Trunk Cable/Lead Set Part Number
AHA 3-wire	M1500A/M1605A
AHA 5-wire	M1520A/M1625A
IEC 3-wire	M1510A/M1615A
IEC 5-wire	M1530A/M1635A

NOTE

3 wire = RA, LA, LL
5 wire = RA, RL, LA, LL + V (C)

Connecting a Patient Cable . The 3-wire or 5-wire patient cable connects to the ECG Input connector located on the front of the defibrillator, behind the carrying handle. The patient cable plug has 6-, 8-, or 12-pins. Before connecting the patient cable, make sure that the pin count of the patient cable plug matches the pin count of the ECG Input connector. To connect the patient cable:

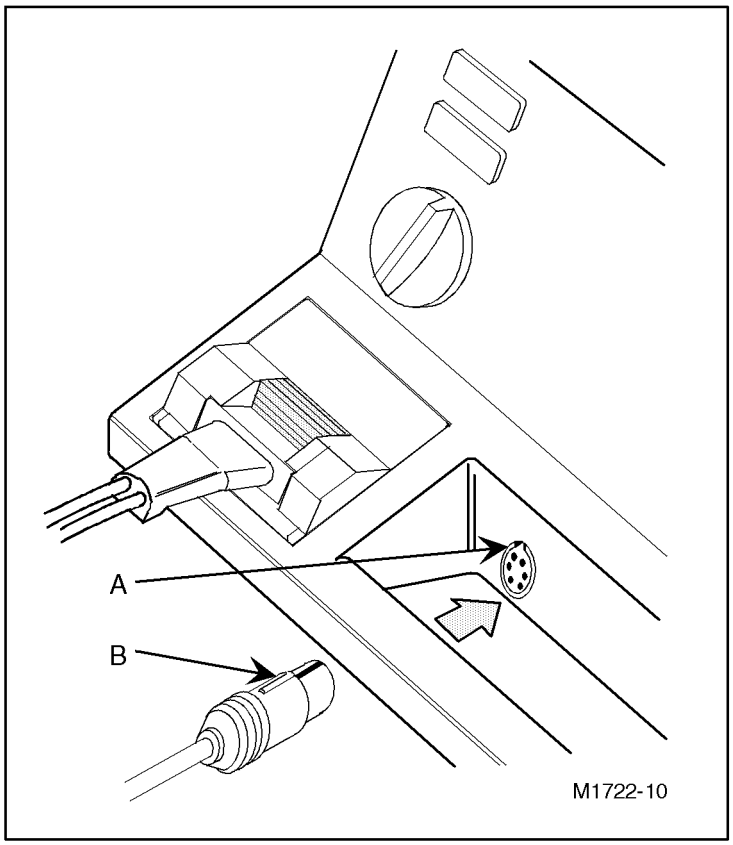
1 Align the keyed cable plug with the slot in the ECG Input connector. See Figure 2-10.

2 Push the cable plug firmly into the ECG Input connector.

NOTE

When a lead is selected for monitoring, the message LEADS OFF appears on the display if the patient cable falls off or is incorrectly connected. Also, a dashed line appears on the display in place of an ECG trace.

Figure 2-10



Connecting a Patient Cable

A ECG Input connector with key slot.

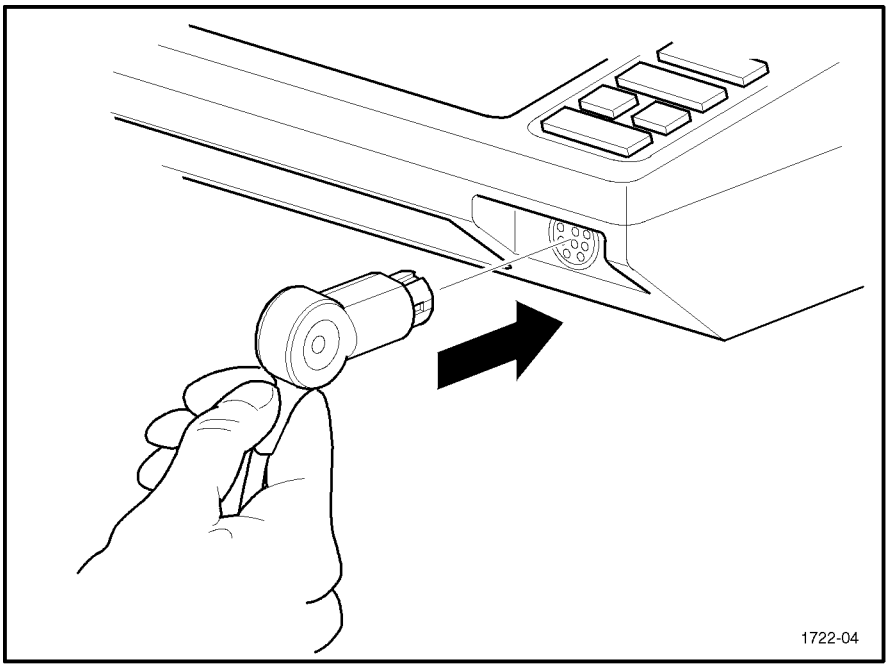
B Keyed plug of patient cable.

SpO_2 Connector

You can attach the HP M1190A SpO_2 sensor or the M1900B adaptor cable to the SpO_2 connector. Refer to the *Sensor Guide* (M1722-93970) for available sensors.

Connecting an SpO_2 Sensor. The M1190A SpO_2 sensor and the M1900B adaptor cable attach to the SpO_2 connector on the front of the defibrillator to the right of the carrying handle. The connector and the end of the cable are color-coded blue. To connect the cable, align the keyed cable plug with the slot on the connector as shown in Figure 2-11, and push the plug firmly into the connector.

Figure 2-11



Connecting an SpO_2 Sensor

Configuration

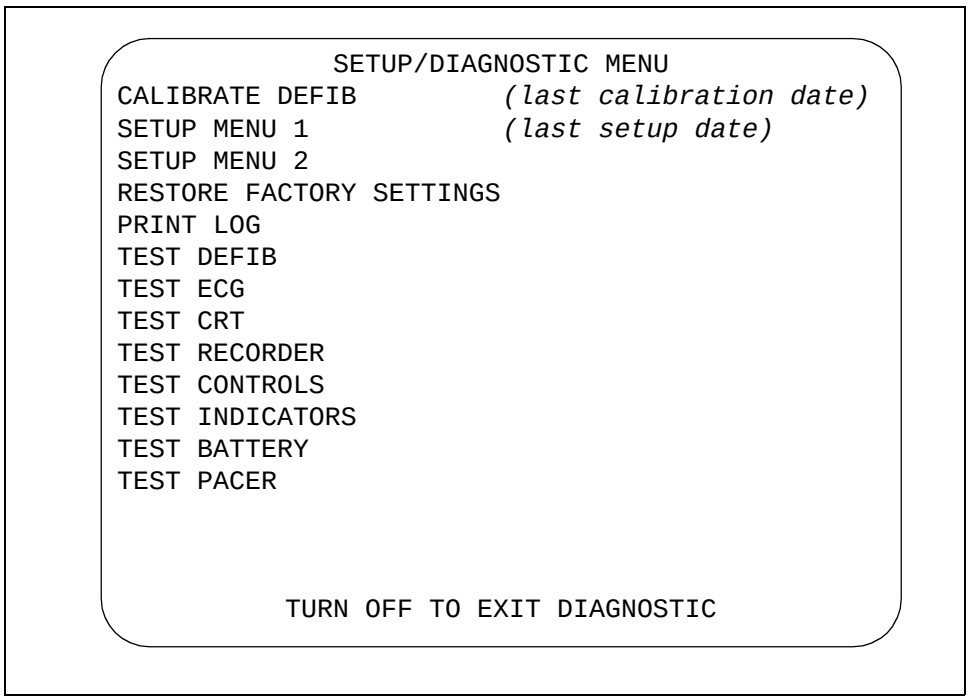
The defibrillator is designed to provide custom operation. Configuration settings let the user program the defibrillator for the most useful and efficient operation. Defibrillator configuration is set at the factory, but should be checked by the technician at initial setup and changed, as desired.

This section describes how to display, print, or change the defibrillator configuration settings and the current date and time.

Displaying the Setup/Diagnostic Menu

To display the setup/diagnostic menu, press both the (Sync) and (HR Alarm) keys while turning the Energy Select control from the **Off (Standby)** to **Monitor On** position. A display with a list of choices appears. Figure 2-12 shows the items on the menu.

Figure 2-12



Setup/Diagnostic Menu

NOTE

The pacer test is displayed on the menu only if the pacer option is installed.

`CALIBRATE DEFIB`

Calibrates the defibrillator. The date when calibration was last performed is normally shown to the right. The date disappears if the stored value that the defibrillator test measures is lost. In either case, performing defibrillator calibration puts the test date on the menu. See “Setup/Diagnostic Menu Tests” on page 3-6 for test information.

`SETUP MENU 1`

`SETUP MENU 2`

Displays setup menu 1 or 2. The date when either menu was last displayed is normally shown to the right of `SETUP MENU 1`. When factory defaults are restored by the user or because configuration is lost, no date is displayed. Displaying either menu puts the date on the menu.

`RESTORE FACTORY SETTINGS`

Changes the configuration settings in the setup menus back to the factory default settings. Exceptions are:

- `LANGUAGE` on setup menu 1 (maintains selected language).
- System date on setup menu 1 (remains unchanged).
- System time on setup menu 1 (remains unchanged).
- `SETUP MENU 1` date is cleared.
- Stored calibration value (maintains last value measured by Defibrillator Calibration; See “Setup/Diagnostic Menu Tests” on page 3-6 for test information.)
- Shock counter (maintains current count; see “The System Log” on page 4-4 for more information.)
- System (error) log (maintains current system log data; see “The System Log” on page 4-4 for more information.)

See Figure 2-13 and Figure 2-14 for factory default settings information.

`PRINT LOG`

Prints the system (error) log. See “The System Log” on page 4-4 for more information.

`TEST xxxx`

These menu items test defibrillator operation. See “Setup/Diagnostic Menu Tests” on page 3-6 for test information.

Displaying/Printing Configuration Settings

To display or print the configuration settings, follow the steps described in Table 2-3.

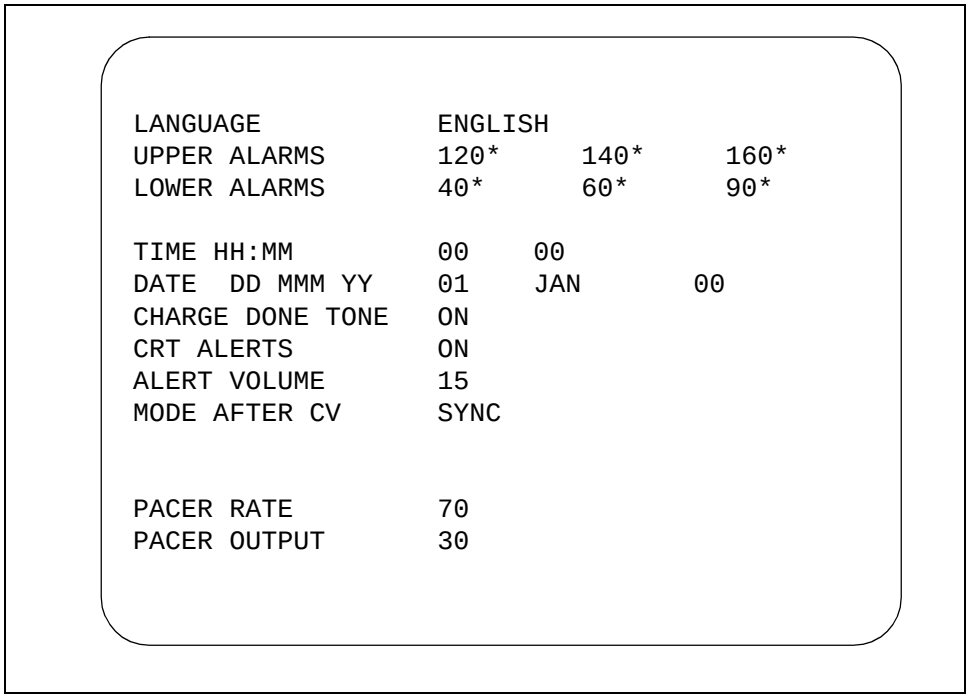
Table 2-3 Displaying/Printing a Configuration Setting

Description	Process
Display the setup/diagnostic menu	Press both the (Sync) and (HR Alarm) keys while turning the Energy Select control from **Off (Standby)** to the **Monitor On** position.
Highlight the setup menu	Press (▼ ECG Size) or (ECG Size▲) to move the highlight over `SETUP MENU 1` or `SETUP MENU 2`.
Display the setup menu	Press (Lead Select) to select the highlighted menu. The display changes to show the configuration settings in the setup menu you selected. The configuration settings listed in each setup menu are shown in Figure 2-13 and Figure 2-14.
Print the current configuration settings	Press (Record). The recorder prints the current settings for *both* setup menus.
Exit the setup menu	Press both arrows on the (▼ ECG Size▲) key, simultaneously, to return to the main setup/diagnostic menu.
Exit setup/diagnostic menu	Turn Energy Select to the **Off (Standby)** position to exit the setup/diagnostic menu.

NOTE

The (▼ ECG Size▲) key has both up and down arrows; pressing s moves the highlight up, and pressing t moves the highlight down.

Figure 2-13



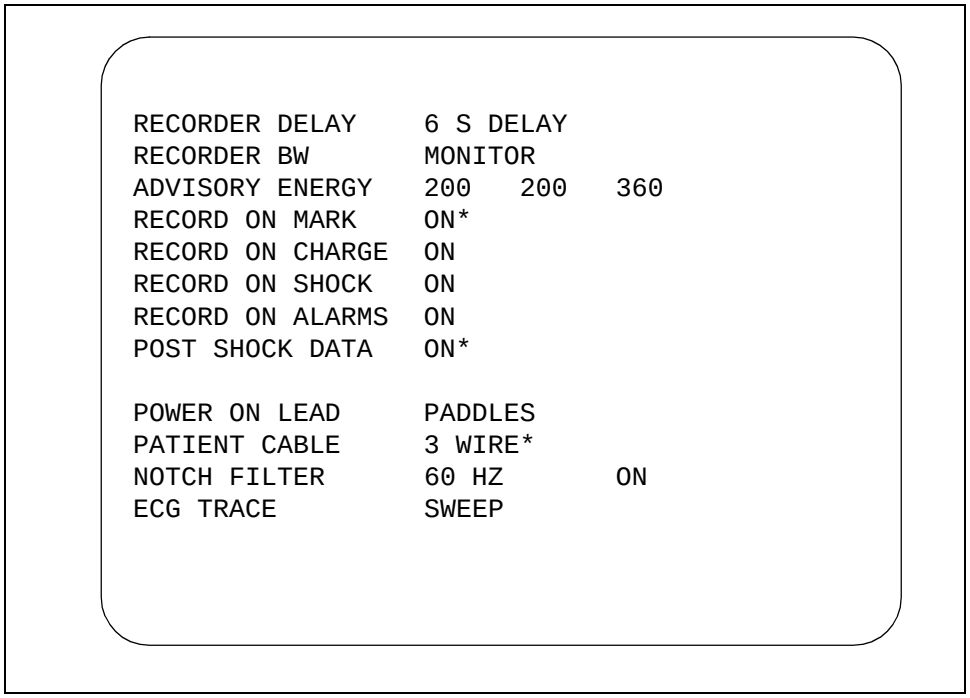
Configuration Default Settings—Setup Menu 1

*These values are fixed, not configurable, and not displayed for the CodeMaster XL.

NOTE

The pacer information is displayed only if the pacer option is installed.

Figure 2-14


RECORDER DELAY 6 S DELAY
RECORDER BW MONITOR
ADVISORY ENERGY 200 200 360
RECORD ON MARK ON*
RECORD ON CHARGE ON
RECORD ON SHOCK ON
RECORD ON ALARMS ON
POST SHOCK DATA ON*
POWER ON LEAD PADDLES
PATIENT CABLE 3 WIRE*
NOTCH FILTER 60 HZ ON
ECG TRACE SWEEP

Configuration Default Settings—Setup Menu 2

*Not shown for CodeMaster XL+ without Option A01. Note that for the Codemaster XL+ without Option A01, RECORD ON MARK is fixed ON, POST SHOCK DATA is fixed OFF, and only the 3-wire paddle set is supported. To return to the main setup/diagnostic menu, press both arrows on the (▼ECG Size▲) key, simultaneously.

To exit the menus, turn the Energy Select control to the **Off (Standby)** position.

Changing Configuration Settings

To change a configuration setting or to change the current date, use the process described next.

WARNING

The setting values of some configuration settings can have critical impact on how your defibrillator operates. Because of this, it is recommended that the biomedical department standardize on a configuration for all defibrillators at the same facility.

If the defibrillator loses your configuration settings, it will display the message SETUP LOST on the screen and use the factory settings for all setup values. To clear the SETUP LOST message, display setup menu 1 or setup menu 2. The "Setup Lost" condition will be cleared when you view the setup menus. You do not have to change the values if you want to keep the factory settings.

Table 2-4 Changing a Configuration Setting

Description	Process
Display the setup/diagnostic menu	Press both the (Sync) and (HR Alarm) keys while turning the Energy Select control from **Off (Standby)** to the **Monitor On** position.
Highlight the setup menu	Press (▼ ECG Size) or (ECG Size▲) to move the highlight over SETUP MENU 1 or SETUP MENU 2. The configuration settings listed in each setup menu are shown in Figure 2-13 and Figure 2-14.
Display the setup menu	Press (Lead Select) to select the highlighted menu. The display changes to show the configuration settings in the setup menu you selected.
Highlight the setting you want to change	Press (▼ ECG Size) or (ECG Size▲) until the highlight appears on the setting you wish to change.
Select the highlighted setting	Press (Lead Select).
Scroll through the possible settings	Press (▼ ECG Size) or (ECG Size▲).
Select the setting	When the choice you want is displayed, press (Lead Select) to set your choice. Repeat this process to change another configuration setting, if desired.
Exit the setup menu	Press both arrows on the (▼ ECG Size▲) key, simultaneously, to return to the main setup/diagnostic menu.
Store settings and exit setup/diagnostic menu	Turn Energy Select to the **Off (Standby)** position to store your setting changes in memory and exit the menus.

Table 2-5 and Table 2-6 show the configuration items and list possible settings. You can change the settings back to the default settings by selecting

RESTORE FACTORY SETTINGS on the setup/diagnostic menu. See "Displaying/ Printing Configuration Settings" on page 2-19 for information on restoring factory default settings.

Table 2-5 Configuration Settings—Setup Menu 1

Configuration Item	Setting Choices	Comments
Language	English, Spanish, Italian, German, French, Swedish, Dutch, Finnish, Danish, Norwegian, Japanese	Selects the language for printed and displayed text.
Upper Alarms[1]	From lower alarm limit to 280, in increments of 5	Sets three upper heart rate limits.
Lower Alarms[1]	From 20 to upper alarm limits, in increments of 5	Sets three lower heart rate limits. In normal operation, one set of limits is displayed and you can cycle through the three limits sets to select the set you want. The first set consists of the upper and lower limits shown on the left in setup menu 1. The second set is the middle setting for each limit. The third set consists of the settings for each limit shown on the right.
Time	hh:mm	Sets the current time.
Date	dd:mmm:yy	Sets the current date.
Charge Done Tone	On or Off	For ON, the defibrillator sounds a continuous tone while it is armed.
CRT Alerts	On or Off	For ON, the defibrillator beeps three times when any CRT Alert message is displayed. OFF turns off CRT alerts.
Alert Volume	3 to 15 (loudest)	Selects the volume of CRT Alerts and HR Alarms.
Mode after CV	Sync or Defib	Selects the defibrillator mode after cardioversion. For SYNC, the defibrillator discharges at next R-wave after the user presses both Shock buttons; for DEFIB, the defibrillator discharges only when user presses discharge buttons.
Settings for the pacer (Option—A01): (Shown when pacer is turned on)		
Pacer Rate	40 to 180 ppm in increments of 10.	Selects the number of pacer pulses per minute (ppm).
Pacer Output	10 to 200 mA in increments of 10.	Selects the amplitude (level) of the pacer pulses, in mA.

[1]For the CodeMaster XL+ without Option A01, the limits values cannot be changed; the factory default values listed in Figure 2-13 and Figure 2-14 are used.

Disabling the Internal Pace Pulse Detection Marker

In normal operation, the defibrillator detects internal pace pulses when monitoring with leads. Internal pace pulse detection is indicated on the screen by a negative spike relative to the ECG baseline.

NOTE

Regardless of this configuration setting, the machine will continue to reject patient internal pace pulses for heart rate calculation.

To enable or disable the Pace Pulse Marker, press (Sync), (HR Alarm), and (Mark) simultaneously while in Setup Menu 1. To determine if this feature is enabled, print out the system log. See "The System Log" on page 4-4 for an explanation of the system log.

Table 2-6 Configuration Settings—Setup Menu 2

Configuration Item	Setting Choices	Comments
Recorder Delay	6 S Delay or No Delay	Recorded ECG is delayed 6 seconds after event, or starts printing immediately.
Recorder BW	Diagnostic or Monitor Diagnostic Frequency Response is only available when monitoring with leads.	Selects the bandwidth of recorder printout. For DIAGNOSTIC, frequency response is from 0.05 to 150 Hz; for MONITOR, from 0.5 to 40 Hz.
Advisory Energy	Energy Select 200, 200, 360 or 200, 300, 360.	Select control from **Off (Standby)** to the desired level.
Record on Mark[1]	On or Off	For ON, the recorder prints when (Mark) is pressed.
Record on Charge	On or Off	For ON, the recorder prints when (Charge) is pressed.
Record on Shock	On or Off	For ON, the recorder prints following a discharge.
Record on Alarms	On or Off	For ON, the recorder prints when a heart rate or SpO_2 alarm violation occurs.
Post Shock Data[1]	Off or On	For ON, recorder prints the delivered (actual) energy statistics. For OFF, recorder prints the Energy Select control setting.
Power On Lead	Paddles, Lead I, II, or III	Selects the default ECG monitoring source at power-on.
Patient Cable[1]	3 Wire or 5 Wire	Sets the defibrillator to treat the input as if either a 3-wire or 5-wire patient cable is attached to the ECG Input connector.
Notch Filter	50 Hz or 60 Hz, On or Off	Selects power line filter frequency, and turns filter on or off.
ECG Trace	Sweep or Scroll	Selects the ECG trace style. SWEEP updates the displayed patient data from left to right, and then repeats the update. For SCROLL, the displayed patient data "moves" from the right to left sides of the display.

[1]On the CodeMaster XL, these menu items cannot be changed; it uses the factory default settings. See Figure 2-13 and Figure 2-14 for factory default setting information

Shock Advisory Algorithm Measurement Matrix Print (optional)

The Advisory Event Summary (AES) includes a configurable option to print the algorithm measurement matrix after each algorithm decision event. This matrix contains the measurements that the algorithm computed during the associated analysis period and on which the algorithm decision is based. This measurement can be used by a factory service representative to understand how the algorithm decision was made.

If you have a question about the algorithm decision for a particular rhythm strip, the measurement matrix printout can be enabled and the AES reprinted with the measurement matrix information, provided the AES memory has not been erased. Save the AES printout with the measurement matrix attached at the end of the strip and contact your service representative.

The factory default for the measurement matrix print option is disabled. A title is printed as the top line, for example, "MEASUREMENTS 27 MAR 96 12:37:20") where the time/date is the same as the decision event time/date.

MEASUREMENTS 27 MAR 96 12:37:20

	D0	D1	D2	D3
M0=	x	x.x	x.x	x.x
M1=	xx	xxxx	xxxx	xxxx
M2=	xx	xx.xx	xx.xx	xx.xx
M3=	xxx	xxx.xx	xxx.xx	xxx.xx
M4=	xxx	xxxx	xxxx	xxxx
M5=	xxxx	xxxxx	xxxxx	xxxxx
M6=	xxxx	xxxxx	xxxxx	xxxxx
M7=	xxx	xx.xx	xx.xx	xx.xx
M8=	xxx	xxx.xx	xxx.xx	xxx.xx
M=9	xx	xxxxx	xxxxx	xxxxx

The matrix rows are for feature measurements and are labelled M0 through M9. The columns record data for internal algorithm decision points are labelled D0 through D3.

The measurement matrix printout can be enabled or disabled by entering diagnostic mode setup menu 1 and simultaneously pressing the (SYNC) and (ANALYZE) keys. This key sequence will toggle the measurement matrix print option from off to on and on to off. The status of the measurement matrix print option is recorded in the system log options area. The software revision of the defibrillator should be "57.00.52.33" greater.

NOTE

Measurement Matrix can be turned ON after the unit has been powered off and then Powered on again. It will still print the Event Summary with the measurement matrix attached to each algorithm decision.

NOTE

After the unit is powered off and then on, the next ECG event, ECG alarm or Mark key pressed will erase the Event Summary. All previous information will be lost.

Performance Verification and Maintenance

Introduction

This chapter describes the tests and inspections required to verify performance of and maintenance procedures for the CodeMaster XL+ and XL Defibrillator/Monitor.

The information is presented in the following sequence:

Test Results Matrix	Lists an overview of performance/ safety tests and provides expected CodeMaster XL+/XL results
Setup/Diagnostic Menu Tests	Explains how to use the defibrillator's built-in Setup/Diagnostic Menu Tests to calibrate the defibrillator and do quick operational checks
Performance Verification	Explains how to verify the defibrillator's performance
Preventive Maintenance	Explains preventive maintenance procedures; including how to check battery capacity and do basic care and cleaning
Equipment List	Lists specifications that must be met by the equipment used to verify the defibrillator's performance
Performance Verification Checklist	Provides a performance verification checklist

For simple checking without using external equipment, you can use the menu-driven tests built into the defibrillator. However, these tests are not as thorough as the tests listed for performance verification. The exception is the battery capacity test, which is a built-in menu-driven test that discharges and monitors the battery voltage. This test is included in preventive maintenance for checking battery capacity.

Test Results Matrix

Table 3-1 summarizes performance verification for the CodeMaster XL+; including test name, test or inspection to perform, expected test results, and data to record. Auxiliary function tests include the CRT Test, the Recorder Test, the Controls Test, and the Indicator Test. Parameter function tests include the SpO2 Test (if option is installed), the HR Alarm Test, the ECG Simulation Test, and the Synch Cardioversion Test. The sections that follow explain the individual tests and inspections in detail.

All performance verification tests outlined in Table 3-1 must be performed following any service procedure performed on the CodeMaster XL+. In addition to testing after servicing, instrument recalibration is always recommended should any of the following events occur:

- If the user suspects that the defibrillator is delivering an energy level lower than the level selected via the Energy Select control.
- If the `CALIBRATE DEFIB` date on the main setup/diagnostic menu is no longer displayed. Refer to Chapter 2, Setup and Configuration for information about the menu. (Note that the defibrillator is shipped with no date displayed).
- If the `SETUP LOST` message is displayed on the screen. Refer to Chapter 2, Setup and Configuration for information about the message.

Table 3-1 Performance Verification: CodeMaster XL+(M1722B)

Test Block Name	Test or "Inspection" to Perform	Expected (Passing) Test Results	Data to Record x=P (pass) or F (fail)
Visual Inspection	• Inspect the unit—including power cord, recorder, electrodes, and cables—for signs of wear, damage, or corrosion • Cycle power off and on; verify indicator light functionality	• No apparent wear, damage or corrosion: • AC Power & Battery Charge light and stay on; Charge, Sync and Pacer On light momentarily	**V:x** **example:** **V:p**
Calibration	**Calibrate defibrillator from the setup/diagnostic menu**	**Message displayed: "Calibration passed"**	**C:x** **example:** **C:p**

Table 3-1 Performance Verification: CodeMaster XL+(M1722B)

Test Block Name	Test or "Inspection" to Perform	Expected (Passing) Test Results	Data to Record x=P (pass) or F (fail)
Defibrillator Test (DT) **(conduct these tests in setup/diagnostic mode)**	**Using only battery power, set Energy Select to 100; test:** • MSec. to charge - aaaa • Delivered Energy - bbb • Impedance - cc • Peak Current - dd **Using only battery power, set Energy Select to 360; test:** • MSec. to charge - eeee • Delivered Energy - fff • Impedance - gg • Peak Current - hh **Using AC power (battery removed), set Energy Select to 360; test:** • MSec. to charge -iiii • Delivered Energy - jjj • Impedance - kk • Peak Current -ll **Conduct Disarm Test (charge to 360; disarm) - m**	 • ≤2000 • 100+/- 15% • 50 Ohm +/- 10% • 30 A +/- 10% • ≤5000 • 360+/- 15% • 50 Ohm +/- 10% • 55 A +/- 10% • ≤15000 • 360+/- 15% • 50 Ohm +/- 10% • 55 A +/- 10% **pass or fail**	**DT:aaaa,bbb,cc,dd, eeee,fff,gg,hh,iiii, jjj,kk,ll,m** **example: DT:1300,100,50, 30,3600,360,50, 55,12000,360,50, 55,p**

Table 3-1 Performance Verification: CodeMaster XL+(M1722B)

Test Block Name	Test or "Inspection" to Perform	Expected (Passing) Test Results	Data to Record x=P (pass) or F (fail)
ECG Tests (E)	**Check:** • Leads Status, Paddle Status, and DSP Status - x • DC Offset - aaa • PCI Calibration o paddles shorted - e o paddles in pocket - fff	**"Good" displayed on screen** **XXX mV** • 0+/-2 ohms • 20 - 100 ohms	**E:x, aaa,e,fff** **example: E:p,0,1,60**
Auxiliary Function Tests (A)	**Conduct the following tests:** • CRT Test • Recorder Test • Controls Test • Indicator Test	**"Pass" displayed on screen for all tests**	**A:x** **example: A:p**
Pacer Test (PT)	**Conduct the Pacer Test with:** • Selected Output set to 40mA - aa • Selected Output set to 100mA - bbb	• Delivered mA is 40mA +/- 5% • Delivered mA is 100mA +/- 10%	**PT:aa,bbb** **example: PT:40,99**

Table 3-1 Performance Verification: CodeMaster XL+(M1722B)

Test Block Name	Test or "Inspection" to Perform	Expected (Passing) Test Results	Data to Record x=P (pass) or F (fail)
Parameter Function Tests (F)	**Conduct the following tests:**		**F:x**
	• SpO2 Test (if option is installed)	• SpO2 option is functional	**example: F:p**
	• HR Alarm Test	• HR alarm sounds at alarm setting	
	• ECG Simulation Test	• leadwires integrity verified; gain settings accurate	
	• Synch Cardioversion Test	• set unit to sync mode; check if defibrillator fires on sync	
Safety Tests(S)	**Check:**		**S:aaa,bbb,ccc,dd, ee,ff**
	• Chassis-to-Ground Resistance - aaa	• ≤ 0.1 ohm	**example: S:09,400,90,7,7,16**
	• Groundwire Leakage Current - bbb	• ≤ 500 uA	
	• Enclosure Leakage Current - ccc	• ≤ 100 uA	
	• Patient Lead Leakage Current		
	o To Ground - dd	• ≤ 10 uA	
	o Between patient leads - ee	• ≤ 10 uA	
	o With line voltage applied - ff	• ≤ 20 uA	
Note: When recording test results, separate tests by a semi-colon(;). For example: V:p;C:p;DT:1300,100,50,30,3600,360,50,55,p;E:p,0,1,60;A:p;PT:40,99;F:p; S:09,400,90,7,7,16			

Setup/Diagnostic Menu Tests

The setup/diagnostic menu tests provide an easy method to check most areas of defibrillator operation and the battery capacity. These tests are available in the setup/diagnostic menu:

- Defibrillator test
- ECG test
- CRT test
- Recorder test
- Controls test
- Indicators test
- Battery capacity test
- Pacer test (Option installed)

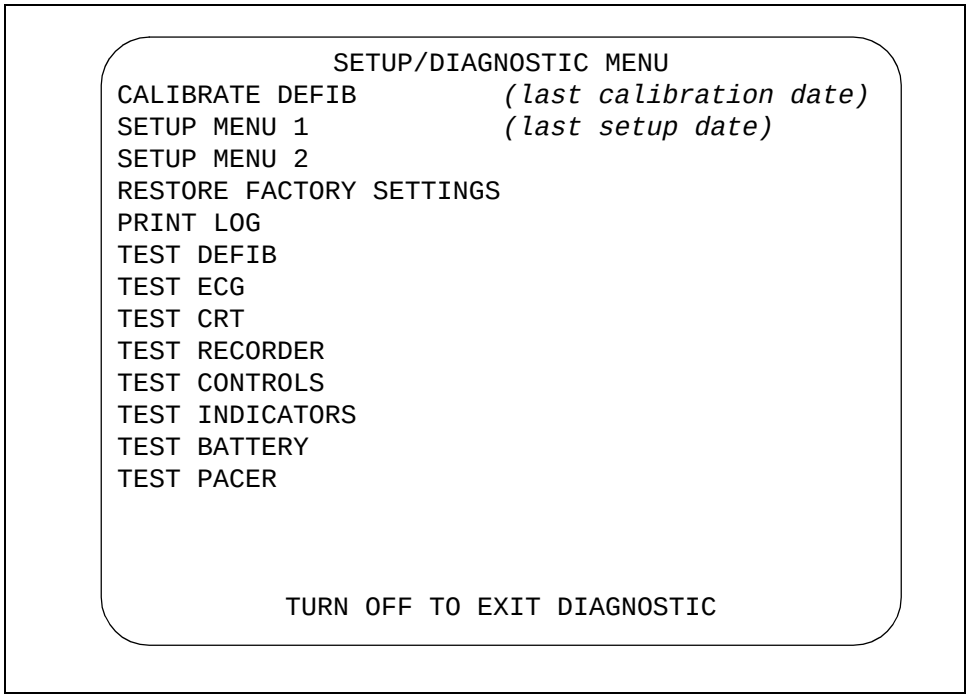
The CRT test, recorder test, controls test, and indicators test require visual verification of displayed or printed output. For these tests, visible failure symptoms appear in the displayed or printed test information, or are shown by indicator operation. For other tests, you determine whether a test has failed by examining test-results data shown on the display.

NOTE

The setup/diagnostic tests do not test the patient electrodes or the 3- or 5-wire patient cables. You can test the patient electrodes and cables by recording an ECG from a patient or ECG simulator as described in “Parameter Function Tests—ECG Simulation” on page 3-26.

To access the setup/diagnostic menu tests, turn the Energy Select control to **Monitor On**, while pressing the (Sync) and (HR Alarm) keys. The following display appears:

Figure 3-1



Setup/Diagnostic Menu

NOTE

The pacer test is listed only if the pacer option is installed.

The dates appear only if the unit has already been calibrated and the configuration has been set up. See “Configuration” on page 2-16 for detailed information.

The setup/diagnostic menu lists the built-in tests and other items. With the panel keys, you step through the menu items and select tests. When you select a test, the display changes to show test information. Using the panel keys to select and start a test is described in Table 3-2. These two keys select and initiate a test:

▼ ECG Size ▲	**Moves the highlight bar down or up, depending on whether you press the left or right side of the key.**
Lead Select	**Selects the menu item that is highlighted.**

Table 3-2 **Performing a Setup/Diagnostic Test**

Description	Process
Highlight the setup/diagnostic menu test	Press (▼ ECG Size) to highlight the test name in the menu.
Select the test	Press (Lead Select) . For some tests, the test that you selected then starts running, and repeats until you stop it. For other tests, the display changes to show test patterns or other test information.
Perform the test	Follow the instructions in this chapter for the test you selected.
To stop a test or return to the setup/diagnostic menu	Press both arrows on the (▼ ECG Size▲) key simultaneously.
To exit the setup/diagnostic menu or exit a test	Turn the Energy Select control to **Off (Standby)**.

Performance Verification

Verify the performance of the defibrillator every six months and after servicing. The procedures listed below make up performance verification. For daily check of the defibrillator, see "Operational Checks" in the *CodeMaster XL+Defibrillator/ Monitor User's Guide"*

The performance verification checklist at the end of this chapter summarizes the tests you should perform to verify the defibrillator's performance. These are some suggested uses for this checklist:

- Make copies of the blank checklist; then, fill out a copy each time the defibrillator is tested.

- Attach the recorder test output, simulator ECG trace, and error log printout to the completed checklist and file with the defibrillator's permanent maintenance record.

Visual Inspection

Before beginning the inspection, turn the Energy Select control to **Off (Standby)** and unplug the power cord from the wall outlet. Then carefully examine the defibrillator and its accessories for the following:

- Worn or damaged power cord

- Loose or missing hardware

• Mechanical damage

• Evidence of liquid spill

• Worn recorder roller

• Worn or damaged cables or connectors

• Corroded or damaged electrodes

• Foreign material on the thermal printhead or paper sensor

Connect the defibrillator to AC power; observe that the AC POWER and BATT CHRG indicators come on. Turn the Energy Select control to **Monitor On** and observe that the Charge and Sync indicators light momentarily, and that the monitor screen displays a trace and other information. Also, the Pacer On indicator should light momentarily (if pacer is installed).

Replace any damaged or missing items and clean the printhead, paper sensor, and patient electrodes as necessary. Leaning instructions are listed under “Preventive Maintenance” on page 3-28.

Defibrillator Calibration

The defibrillator should be recalibrated after any of the following events:

• The user suspects that the defibrillator is delivering an energy level lower than the level selected via the Energy Select control.

• The CALIBRATE DEFIB date on the main setup/diagnostic menu is no longer displayed. See Table 2-3, “Displaying/Printing a Configuration Setting,” on page 19 for information about the menu. (Note that the defibrillator is shipped with no date displayed).

• The SETUP LOST message is displayed on the screen. See “Configuration” on page 2-16 for information about the message.

• After servicing which requires replacement of the HV capacitor, the Control board, or each time the unit is opened.

• After each scheduled preventive maintenance.

When the defibrillator charges, it uses a measured value for the capacitance of the charge capacitor to determine the energy required to reach the selected charge level. The CALIBRATE DEFIB choice on the menu guides the user through a routine that measures the capacitance of the HV capacitor, and adjusts the capacitance value based on the routine's results. The capacitance value is stored in battery-maintained memory and

used each time the defibrillator is charged. On the TEST DEFIB screen, the stored capacitance value is displayed after CAPACITANCE.

WARNING

Avoid touching any metal surfaces on the defibrillator and do not touch equipment connected to the defibrillator during shock. Dangerous high voltage exists on the paddles when the defibrillator is discharged. Contact with this high voltage could cause death or serious injury.

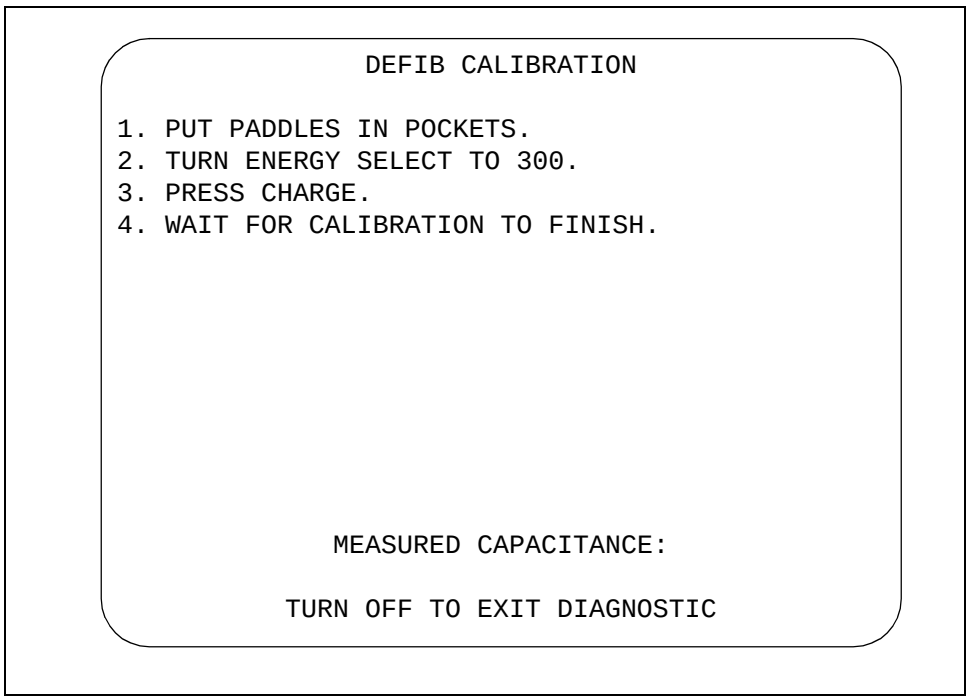
Test Prerequisites

Connect the external paddles and place them firmly in their holders in the defibrillator.

Calibrating the Defibrillator

To start the defibrillator calibration routine, select CALIBRATE DEFIB on the setup/diagnostic menu; the screen displays the information shown in Figure 3-2.

Figure 3-2


DEFIB CALIBRATION
1. PUT PADDLES IN POCKETS.
2. TURN ENERGY SELECT TO 300.
3. PRESS CHARGE.
4. WAIT FOR CALIBRATION TO FINISH.
MEASURED CAPACITANCE:
TURN OFF TO EXIT DIAGNOSTIC

Calibrate Defibrillator Screen

Follow the instructions displayed on the screen. (If you set the Energy Select control to a level below 300 joules, the message, BAD USAGE: SEE MANUAL is displayed.)

If the test completes successfully, `CALIBRATION PASSED` is displayed at the bottom of the screen. If the test fails, `CALIBRATION FAILED` is displayed and the nominal capacitance value is used; see Chapter 4, Troubleshooting, and Table 4-13 for detailed troubleshooting information.

Defibrillator Test

This test verifies defibrillator performance to specifications. You should run the **Defibrillator Calibration routine before performing the Defibrillator Test**. You can perform the defibrillator test using either external paddles or pads.

WARNING

If using pads adapter M1750A/B, connect an M1781A test load when performing the defibrillator test.

Test Prerequisites

Connect the external paddles and place them firmly in their holders in the defibrillator or attach the M1781A test load if you are using the pads adapter cable. The battery must be fully charged.

Testing the Defibrillator

It is recommended that you test the defibrillator in the power configuration in which it is normally used: battery only, or AC power. You should also test the disarm function as described at the end of the defibrillator test.

The test is designed to check the defibrillator in these power configurations:

• With fully-charged battery installed; no AC power.

• With the defibrillator plugged into AC power; battery is removed.

With the defibrillator powered by battery only, you run the test at 100 joules and at 360 joules. The values of some test results vary depending on the power configuration being used. Table 3-3 lists acceptable test result values for each power configuration.

To run the Defibrillator Test, follow these steps:

1 For battery only testing:

a. Make sure that the battery is installed and is fully charged.

b. Disconnect the defibrillator from AC power.

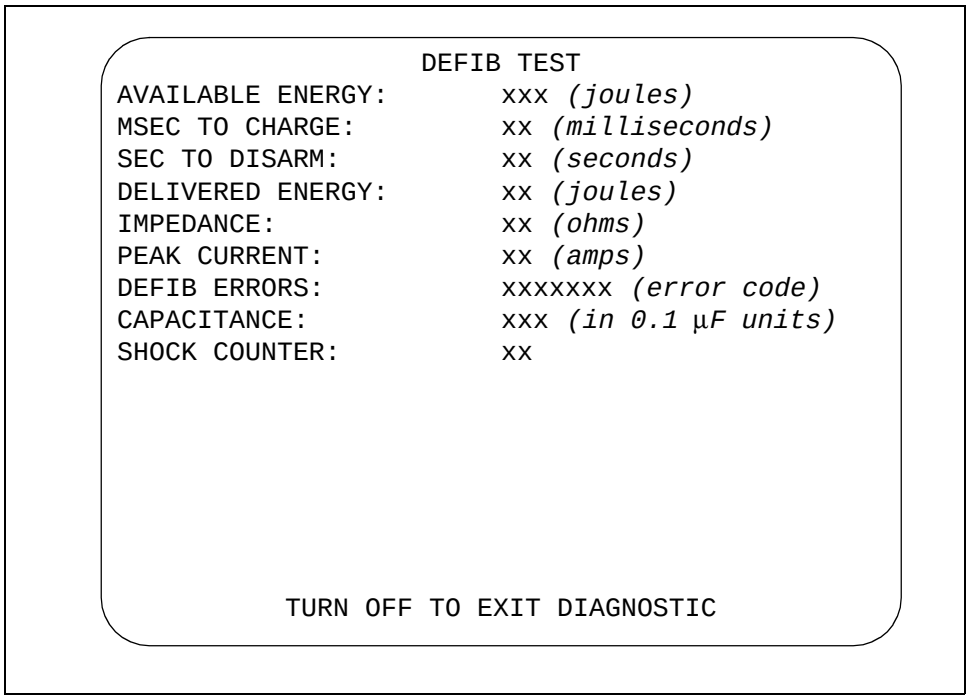
For AC power only testing:

a. Disconnect the battery.

b. Plug the defibrillator into AC power.

2 Select `TEST DEFIB` in the setup/diagnostic menu; the screen displays the information shown in Figure 3-3. This table shows defibrillator performance parameters. Some of these parameters are not available until after the defibrillator is discharged.

Figure 3-3


DEFIB TEST
AVAILABLE ENERGY: xxx (joules)
MSEC TO CHARGE: xx (milliseconds)
SEC TO DISARM: xx (seconds)
DELIVERED ENERGY: xx (joules)
IMPEDANCE: xx (ohms)
PEAK CURRENT: xx (amps)
DEFIB ERRORS: xxxxxxx (error code)
CAPACITANCE: xxx (in 0.1 μF units)
SHOCK COUNTER: xx
TURN OFF TO EXIT DIAGNOSTIC

Defibrillator Test Screen

AVAILABLE ENERGY:	**Current charge in joules; 0 when the defibrillator is not armed.**
MSEC TO CHARGE:	**After the defibrillator charges to the energy level selected, the entry shows how many milliseconds the charge required.**
SEC TO DISARM:	**After the defibrillator signals Charge Done, it holds the charge for 60 seconds, and then starts disarming the charge through an internal safety relay. The entry shows the time required to disarm the defibrillator to the "safe" state.**
DELIVERED ENERGY:	**The calculated delivered energy (in joules) based on the internal peak current measurement.**
IMPEDANCE:	**The calculated load impedance based on available energy and the internal peak current measurement (in Amps).**
PEAK CURRENT:	**The peak current measured during defibrillator discharge.**
DEFIB ERRORS:	**Defibrillator errors that have occurred while in diagnostic test mode.**

CAPACITANCE:	**The capacitance used when charging the defibrillator. The capacitance value is established during Defibrillator Calibration (See "Defibrillator Test" on page 3-11 for information).**
SHOCK COUNTER:	**The number shown is the number of shocks since the shock counter was reset. You can clear the shock counter by pressing the (Sync) and (HR Alarm) keys simultaneously, while displaying this screen. Only clear the shock counter after replacing a patient circuit component, such as the high voltage (HV) capacitor, HV inductor, patient relay, or HV charger board. Record the value of the shock counter prior to clearing it.**

3 Turn the Energy Select control to the energy level for the power configuration you selected.

4 Press (Charge). The value for AVAILABLE ENERGY increments.

5 Check that it reaches the energy level you selected, when the Charge Done LED is lit on the front panel or the apex paddle.

6 Check that the entry for MSEC TO CHARGE is within the limits listed in Table 3-3 for the power configuration you selected.

WARNING

Avoid touching any metal surfaces on the defibrillator and do not touch equipment connected to the defibrillator during shock. Dangerous high voltages exist on the paddles when the defibrillator is discharged. Contact with this high voltage could cause death or serious injury.

7 Discharge the defibrillator by pressing the two shock buttons.

8 Check that the values for DELIVERED ENERGY, IMPEDANCE, and PEAK CURRENT are within the limits listed in Table 3-3.

NOTE

If the displayed Impedance is outside these limits, see "Adjusting the Internal Delivered Energy Calibration" on page 5-30.

To test the automatic disarm function:

9 Press (Charge) again.

10 Wait until an alternating tone sounds, and then the AVAILABLE ENERGY value decrements to 0.

11 Repeat the test for the other power configuration if you are doing the battery only test; or for the other energy level, if desired.

Table 3-3 Defibrillator Test Limits

Defibrillator Configuration	Available Energy	MSec to Charge	Sec to Disarm	Delivered Energy	Impedance	Peak Current
Battery Only	100 j	< 2000	–	85–115 j	45–55Ω	26–33 A
	360 j	< 5000	–	306–414 j	45–55Ω	50–60 A
AC Only (Battery removed)	360 j	< 15000	–	306–414 j	45–55Ω	50–60 A
Disarm Test	360 j	–	pass or fail			

To test the manual disarm function:

12 Turn the Energy Select control to 360 joules.

13 Press (Charge).

14 When the charge reaches 360 joules, turn the Energy Select control directly to **Monitor On**. Turn the control quickly and do not stop at any level selection between 360 joules and the **Monitor On** position. This step disarms the defibrillator.

15 Check to see that the `SEC TO DISARM` test passed or failed as listed in Table 3-3.

16 Press both sides of (▼ECG Size▲) at once, to exit the test menu.

Delivered Energy Level Test

To perform the delivered energy level test, you need a test box. See Table 3-5 for equipment specifications. The test checks that the delivered discharge energy measured by the test box is equivalent to the charge level displayed on the defibrillator.

To verify the delivered energy level, follow the instructions provided with the test box.

WARNING

Avoid touching any metal surfaces on the defibrillator and do not touch equipment connected to the defibrillator during shock. Dangerous high voltage exists on the paddles when the defibrillator is discharged. Contact with this high voltage could cause death or serious injury.

ECG Tests

This test verifies the operation of the leads and paddles ECG front end amplifiers and checks digital signal processor filtering. The test also verifies communication between the front end board and the control board.

Test Prerequisites

Requires a calibrated ECG simulator for use with pads and leads. Also requires an AAMI simulated patient load. See “Equipment List” on page 3-32 for equipment information.

Testing the ECG

To run the ECG test, follow these steps:

1 Select `TEST ECG` in the setup/diagnostic menu; the display shows the information shown in Figure 3-4.

Figure 3-4

```
                    ECG TEST
SELECTED LEAD:          PADDLES
NOTCH FILTER:           50 or 60 HZ   ON


LEADS STATUS:           GOOD
PADDLES STATUS:         GOOD
DSP STATUS              GOOD
DC OFFSET:              xxx (mV)
PEAK TO PEAK:
   DIAGNOSTIC:          xxxx (µV)
   MONITOR:             xxxx (µV)
PCI:                    ohms ON



          TURN OFF TO EXIT DIAGNOSTIC
```

ECG (Monitor) Test

`SELECTED LEAD:`	**Lets you select the ECG source.**
`NOTCH FILTER:`	**Current power line filtering frequency: 50 or 60 Hz; you can change the filtering and turn the filter off and on.**
`LEADS STATUS:`	`GOOD` **indicates that communication between the Leads Front End and DSP is acceptable.**
`PADDLES STATUS:`	`GOOD` **indicates that communication between the paddles/ Front End and DSP is acceptable.**
`DSP STATUS:`	`GOOD` **indicates that the DSP is communicating properly with the monitor.**

DC OFFSET:	**An offset value used when measuring Leads Off. Largest absolute value offset of any wire used in lead combination according to the lead selected (mV).**
PEAK TO PEAK DIAGNOSTIC: MONITOR:	**Peak-to-peak signal of the** SELECTED LEAD **measured over a one-second interval. Results are given for both** MONITOR **(0.5Hz to 40 Hz) and** DIAGNOSTIC **(0.05Hz to 150 Hz) bandwidth.**
PCI:	**Paddles impedance measured in ohms. Used to determine** PADDLES OFF**, and for PCI (paddles contact indicator) bar graph on sternum paddle. Patient impedance can be calibrated. See "PCI Calibration" on page 3-16 for instructions.** PCI ON **indicates that displayed data is calibrated.** PCI OFF **indicates that displayed data is not calibrated.**

2 Check that LEADS STATUS is GOOD.

3 Check that PADDLES STATUS is GOOD.

4 Check that DSP STATUS is GOOD.

PCI Calibration

PCI calibration should be performed whenever setup is lost or whenever the user suspects that PCI indication is wrong. Perform the following steps to calibrate PCI.

1 Attach the paddle set to the defibrillator.

2 Access the setup/diagnostic menu.

3 Select TEST ECG in the setup/diagnostic menu.

4 Press (Sync) and (HR Alarm) simultaneously, so that OFF appears to the right of the PCI value.

5 While shorting the paddles together, press (Sync) and (HR Alarm) simultaneously. The PCI value should now indicate 0±2 ohms and ON should now appear next to the PCI value.

NOTE

Turning the PCI indicator off, then on again calibrates it to 0 ohms. **If you do not** short the paddles together, you will miscalibrate the PCI indicator.

6 Replace paddles in pockets. The PCI value with the paddles in the pockets should be between 20 and 100 ohms (the PCI value varies because of inductance in the circuit).

Auxiliary Function Tests—CRT Test

This test lets you check the operation and alignment of the CRT.

Test Prerequisites

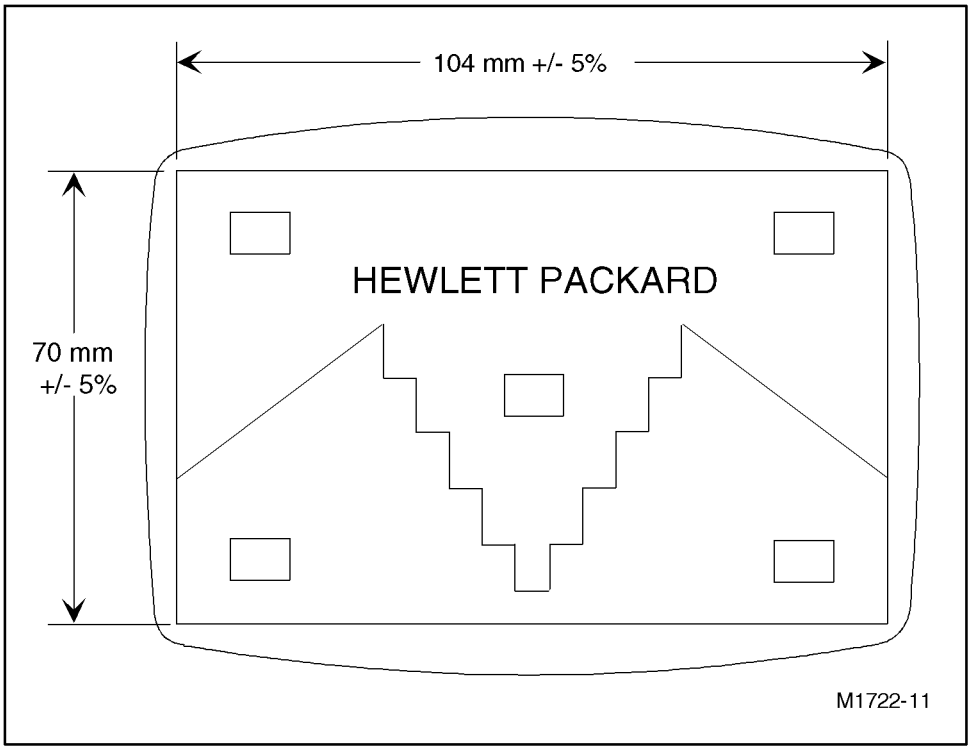
A ruler that measures in millimeters is required to measure the display size.

Testing the CRT

To perform the CRT test, follow these steps:

1 Select TEST CRT in the setup/diagnostic menu; the display shows the information shown in Figure 3-5.

Figure 3-5



CRT Test: Test Pattern

2 To determine whether the defibrillator CRT meets specifications, observe the test pattern to ensure:

• accurate rendition of all lines

• no random lines or dots in the display

NOTE

If any of the following steps require adjustment, see "Adjusting the CRT" on page 5-27 for adjustment information.

3 Check that the height and width of the display is within the limits shown in Figure 3-5.

4 Check that all lines and characters are in focus.

5 Check that the display is centered on the CRT face, vertically and horizontally. Check that the display is aligned horizontally and vertically.

6 Check that the intensity of the displayed image is acceptable.

Auxiliary Function Tests—Recorder Test

The recorder test checks recorder parameters and prints a test pattern to check the printhead and paper drive mechanism.

Test Prerequisites

Recorder paper, and a ruler that measures in millimeters.

Testing the Recorder

To run the recorder test, follow these steps:

1 Check that the recorder contains paper.

2 Highlight `TEST RECORDER` on the main setup/diagnostic menu.

3 Press (Record) or (Lead Select) . The recorder starts printing a series of test patterns.

4 When the printed strip is about 3 feet long, press (Record) or (▼ ECG Size ▲) to stop the printing and return to the setup/diagnostic menu. Figure 3-6 shows the areas of the test pattern.

• Inspect the recorder strip for: Consistent print quality for all pattern areas

• Constant width for all pattern areas

• Straight diagonal lines

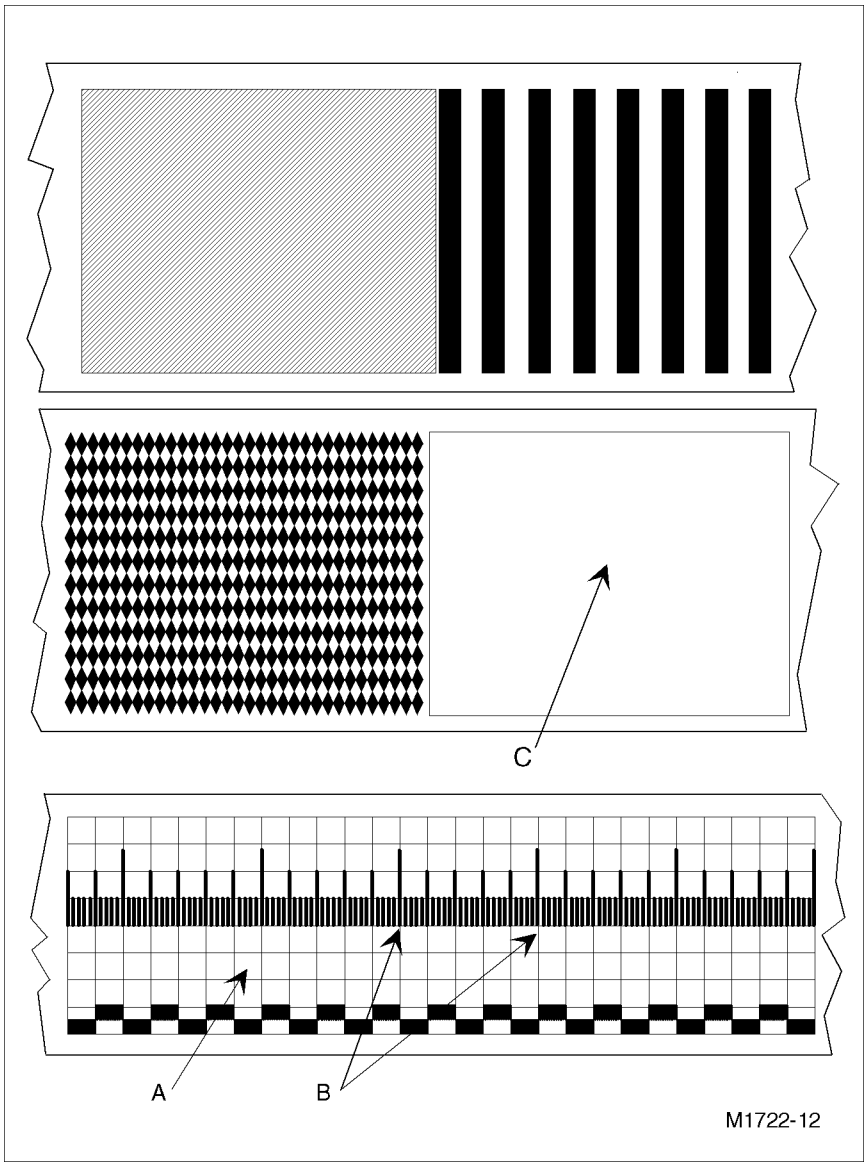
• Visible separation between the close parallel lines

• Clean black bars with no dropout in black areas

• Accurate rendition of all characters

• A distance of 25 mm ±2 mm between the longest tick marks (5 mm between the intermediate tick marks)

Figure 3-6



Recorder Test: Test Pattern

A. Test pattern for checking print speed

B. Major tick marks

C. Test pattern printout of all characters and symbols.

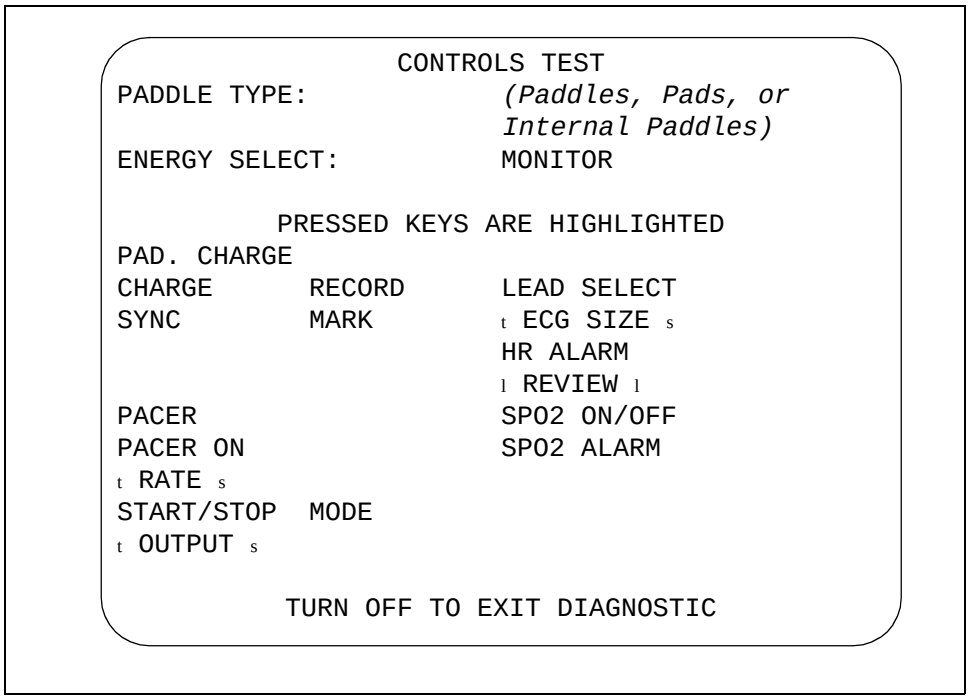
Auxiliary Function Tests—Controls Test

This test checks the operation of the panel keys.

To test the panel key operation, follow these steps:

1 Select TEST CONTROLS in the setup/diagnostic menu. The information shown in Figure 3-7 is displayed.

Figure 3-7



Controls Test

NOTE

The pacer information is displayed only if the pacer option is installed.

2 Check that the entry for PADDLE TYPE matches the type that is attached (paddles, pads, or internal paddles).

If you disconnect the paddles cable, the entry changes to NONE.

3 Turn the Energy Select control to each energy level position, checking that the entry for Energy Select on the display matches the current control position.

4 Under PRESSED KEYS ARE HIGHLIGHTED, press each key listed. Simultaneously, check that the key name in the display is highlighted while the key is

depressed. Highlighting indicates that the defibrillator has detected the key press. See Table 3-4 for a list of keys and the response you should see on the monitor display.

Table 3-4 **Controls Test Steps**

Key	Key Press	Response on Display
Paddles Charge	Press the Charge button on the side of the right external paddle.	PADDLES,PADS, or INTER-NAL PADDLES is highlighted.
(Charge)	Press the panel (Charge) key.	CHARGE is highlighted.
(Sync)	Press the panel (Sync) key.	SYNC is highlighted.
(Record)	Press the panel (Record) key.	RECORD is highlighted.
(Mark)	Press the panel (Mark) key.	MARK is highlighted.
(Lead Select)	Press the panel (Lead Select) key.	LEAD SELECT is highlighted.
(▼ ECG Size▲)	Press the panel (▼ ECG Size) key.	The ▲ arrow is highlighted.
	Press the panel (ECG Size▲) key.	The ▼ arrow is highlighted.
(HR Alarm)	Press the panel (HR Alarm) key.	HR ALARM is highlighted.
(● Review ●)	Press the (● Review) key.	The left ● is highlighted.
	Press the panel (Review ●) key.	The right ● is highlighted.
XL+ only, with pacer option installed:		
(Pacer On)	Press the (Pacer On) key.	PACER ON is highlighted.
(▼Rate▲)	Press the panel (▼ Rate) key.	The ▲ arrow is highlighted.
	Press the panel (Rate ▲) key.	The ▼ is highlighted.
(Start/Stop)	Press the panel (Start/Stop) key.	START/STOP is highlighted.
(▼ Output ▲)	Press the panel (▼ Output) key.	The ▲ arrow is highlighted.
	Press the panel (Output ▲) key.	The ▼ arrow is highlighted.
(Mode)	Press the panel (Mode) key.	MODE is highlighted.
With SpO_2 option installed:		
(SpO_2 On/Off)	Press the panel (SpO_2 On/Off) key	SPO2 ON/OFF is highlighted.
(SpO_2 Alarm)	Press the panel (SpO_2 Alarm) key	SPO2 ALARM is highlighted.

Auxiliary Function Tests—Indicator Test

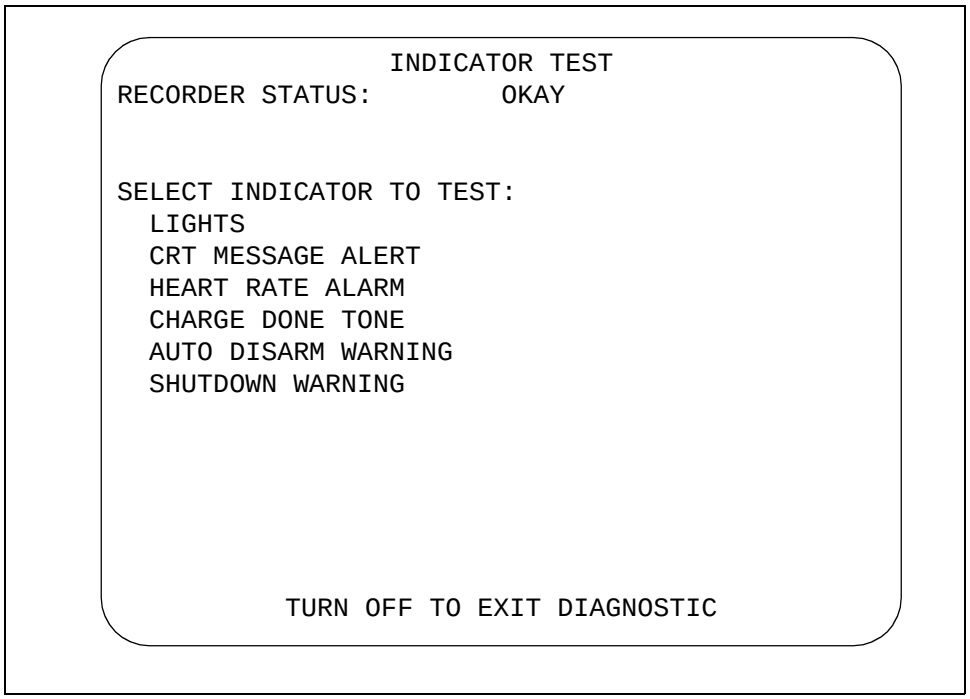
The indicator test exercises each LED and audio tone controlled by the defibrillator.

Testing the Indicators

To test the defibrillator indicators, follow these steps:

1 Select TEST INDICATORS on the setup/diagnostic menu; the defibrillator displays the information in Figure 3-8.

Figure 3-8



Indicators Test

2 Check that the entry for RECORDER STATUS is OKAY. (If the recorder is out of paper, the entry is CHECK.)

3 The items under SELECT INDICATOR TO TEST are tests for the lights and audible tones. Use the (▼ECG Size▲) and (Lead Select) keys to select and start a test. To stop one of these tests, press (Lead Select) again. Each test is described, next.

LIGHTS	**Sequentially lights the (Sync), the key panel (CHARGE DONE), the pacer (Pacer On), and the paddle (CHARGE DONE) indicators for about one second, each. If the unit has PCI indicators, they are lit while the LIGHTS test is running.**
CRT MESSAGE ALERT	**Generates the CRT Alert tone: three short tones; after a pause, the tones repeat.**
HEART RATE ALARM	**Generates a continuous tone.**

CHARGE DONE TONE	**Generates a continuous tone; this tone is lower in frequency than the Heart Rate Alarm tone.**
AUTO DISARM WARNING	**Generates an intermittent tone that is the same frequency as the Charge Done tone.**
SHUTDOWN WARNING	**Outputs a tone that alternates continuously between the Charge Done tone and the HR Alarm tone frequencies.**

Pacer Test (Option installed)

Testing the pacer does not check the energy level that pacing delivers; testing verifies that the current delivered is equivalent to the levels indicated on the defibrillator screen.

To verify pacer operation, use a commercially available pacer tester. See Table 3-5 for equipment information. Follow the instructions provided with the pacer tester to perform the test.

Test Prerequisites

A test load (HP M1781A) is required.

Testing the Pacer

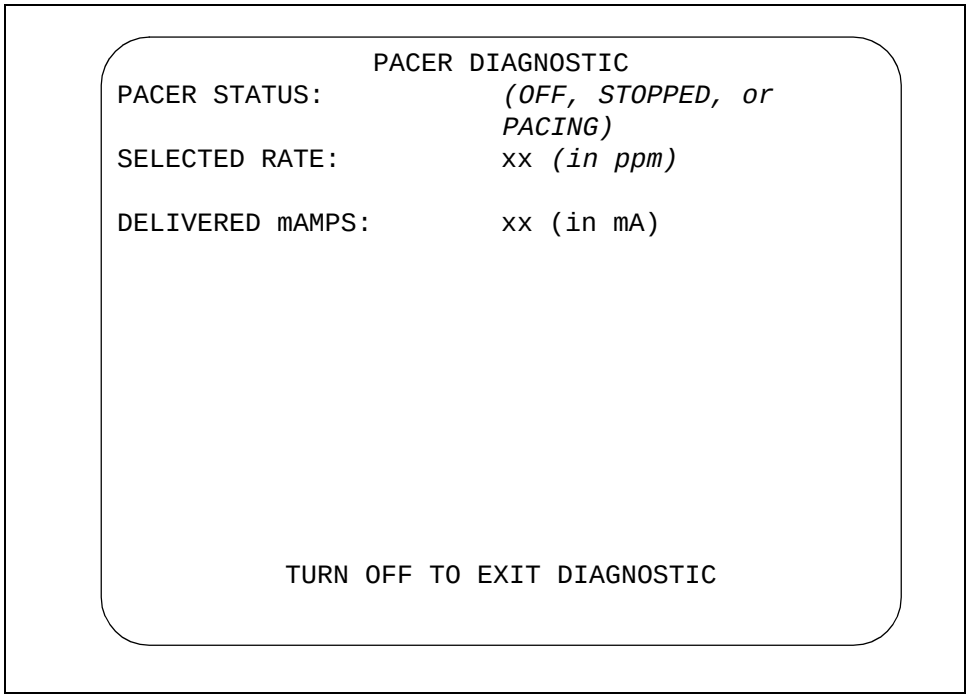
Follow these steps to perform the pacer test:

1 While pressing the (Sync) and (HR Alarm) keys, turn the Energy Select control from the **Off (Standby)** position to **Monitor On**. The setup/diagnostic menu appears after a moment.

2 Select TEST PACER on the setup/diagnostic menu.

3 Press (Lead Select) to select the Pacer test. The monitor displays the information shown in Figure 3-9.

Figure 3-9


PACER DIAGNOSTIC
PACER STATUS: (OFF, STOPPED, or PACING)
SELECTED RATE: xx (in ppm)
DELIVERED mAMPS: xx (in mA)
TURN OFF TO EXIT DIAGNOSTIC

Pacer Test

PACER STATUS	**Shows whether the pacer function is turned off, is turned on but is not pacing (**STOPPED**), or is pacing (**PACING**). The** (Pacer On) **key turns the pacing function on and off; pacing can be turned on and also be stopped. (**PACER STATUS **may also show** NO PADS **or** PADS OFF **momentarily after** START **is pressed.)**
SELECTED RATE	**Indicates the current output rate, in pulses per minute, as selected by the pacer** (▼ Rate ▲) **key.**
DELIVERED mAMPS	**Indicates the output level of the delivered pulses as measured by the defibrillator, in mA.**

4 Connect the test load (HP M1781A).

5 Press (Pacer On) once, to turn on the pacer function. The indicator in the key should turn on; PACER STATUS should say STOPPED.

6 Press (▼ Output ▲) to increment the pulse output to the desired level. The current level is displayed on the screen.

7 Press (Start/Stop) **to start pacing. PACER STATUS should say PACING.**

8 Check that the DELIVERED mAMPS on the display is within these specifications:

Output Level	DELIVERED mAMPS
≤50 mA:	± 5 mA
> 50mA:	± 10%

Parameter Function Tests—SpO_2 Test

Testing of the SpO_2 option includes an internal self-test and a functional test.

SpO_2 Internal Self-Test

Every time the SpO_2 monitoring is turned on, the instrument runs a self-test on the SpO_2 PCA.

1 Turn the defibrillator on by turning the Energy Select switch to Monitor On.

2 Press the SpO_2 On/Off button to turn SpO_2 monitoring on.

3 Verify that no error messages appear on the display.

4 Press the SpO_2 On/Off button to turn SpO_2 monitoring off.

SpO_2 Functional Test

1 Attach an SpO_2 sensor to a normal, healthy person. Refer to the sensor packaging for directions on how to attach the sensor.

2 Plug the sensor into the defibrillator. If you are not using a Hewlett-Packard sensor, you must use the M1900B adaptor cable.

3 Turn the Energy Select switch to Monitor On.

4 Press the SpO_2 On/Off button.

5 After 15 seconds, verify that the display shows an SpO_2 reading and a pulse rate.

6 Verify that the Pulse Amplitude Indicator moves up and down.

7 Verify that the SpO_2 reading is between 95% and 100%. If the SpO_2 reading is much below 95% and the person is healthy, the reading indicates a monitor or sensor error.

8 Press the SpO_2 On/Off button to turn SpO_2 monitoring off.

Parameter Function Tests—HR Alarm Test

To test the HR Alarm an ECG simulator is needed.

1 Run a normal ECG at 60 Hz

2 Press (HR Alarm), verify alarm setting in upper right corner of the display

3 Change the ECG simulator to get beyond both the upper and lower HR Alarm limits.

4 After a few seconds (approximately six seconds) the recorder will print a report and the alarm will sound.

Parameter Function Tests—ECG Simulation

Taking an ECG using a 12-lead ECG simulator lets you verify areas of operation that the setup/diagnostic menu tests cannot test:

• the integrity of the leadwires

• the accuracy of the gain settings

To simulate an ECG, use a commercially available ECG simulator. Follow the testing instructions provided with the simulator.

Parameter Function Tests—Sync Cardioversion Test with External Monitor

The sync cardioversion test should be performed only if the defibrillator will be used with an external monitor as the synchronizing source. The test verifies that the delay introduced by the external monitor is <60 ms of the R-wave detected.

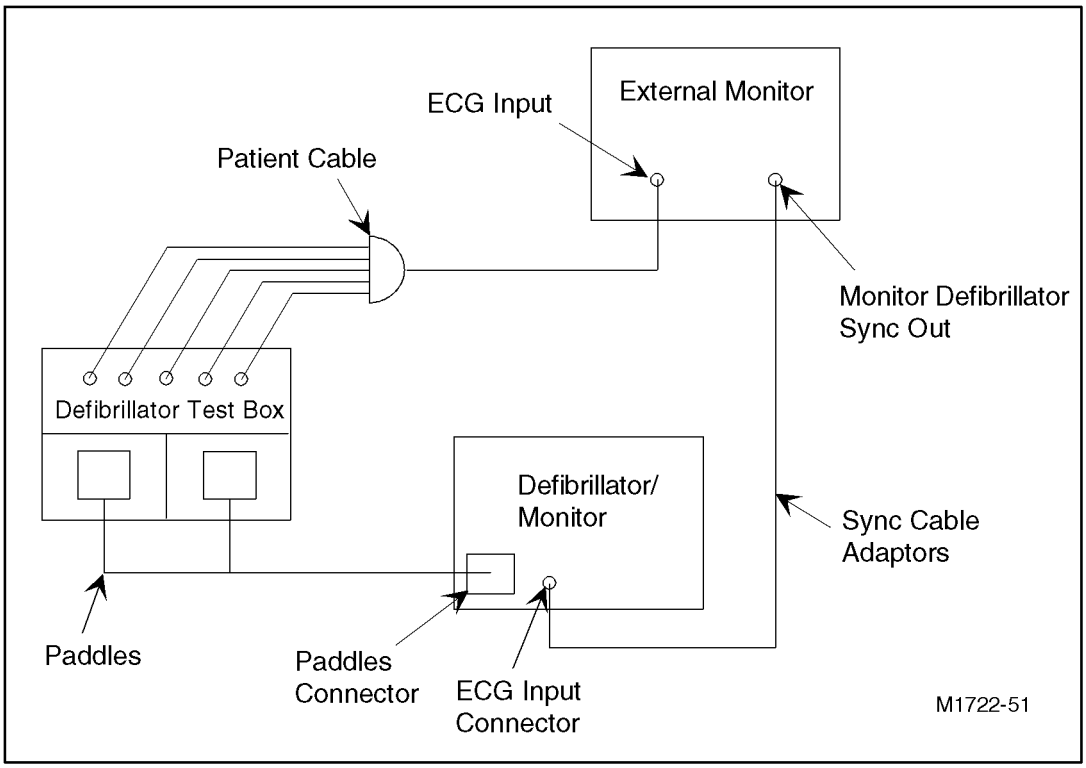
Using an external monitor as the synchronizing source adds some amount of delay between the patient R-wave and defibrillator discharge. This test verifies that the total delay is within acceptable limits (<60ms).

To test sync cardioversion with an external monitor, follow this procedure:

1 Use a defibrillator test box capable of measuring synchronized cardioversion delay time.

2 Connect a patient cable between the defibrillator test box and the external monitor. See Figure 3-10.

Figure 3-10



Sync Cardioversion Test Setup

3 Connect the sync interface cable between the external monitor's DEFIB/SYNC output and the defibrillator ECG In connector.

4 Set up the external monitor to monitor LEAD II.

5 On the defibrillator, select LEAD II as the ECG source.

6 Put the defibrillator test box into cardioversion test mode.

7 Press (Sync) on the defibrillator to put the instrument in sync mode. The ECG signal should have synchronization markers highlighting the ECG trace. Adjust ECG SIZE, if necessary.

8 Turn the Energy Select control on the defibrillator to 50 joules.

9 Place the paddles on the defibrillator test box paddle pads; press the charge button on the apex paddle. Wait for the Charge Done indicators on the defibrillator.

10 Press and hold both shock buttons on the paddles until the defibrillator discharges.

Safety Tests

The safety tests listed below are performed at the time of manufacture to assure compliance with these standards: IEC 601-1, IEC 601-2-4, UL 544, and CSA 22.2 No. 601.1.

- Chassis-to-ground resistance within an expected range of < 0.1 ohm
- Ground wire leakage current within an expected range of < 500 uA
- Enclosure leakage current within an expected range of < 100 uA
- Patient lead leakage current (source leakage) to ground within an expected range of < 10 uA
- Leakage current between patient leads within an expected range of < 10 uA
- Patient lead leakage current (sink current) with line voltage applied within an expected range of < 20 uA

These tests should be part of your preventive maintenance program, and should be performed after any corrective maintenance to assure continued compliance with the named standards.

To perform these tests, use commercially available safety testers or analyzers designed specifically for this purpose. Follow the manufacturer's operating instructions for hookup and test procedures.

Preventive Maintenance

Preventive maintenance for the defibrillator is a superset of performance verification and consists of the battery capacity test, printing the system error log, cleaning and inspection, followed by routine maintenance and/or troubleshooting.

CAUTION

The defibrillator does not require any kind of lubrication. Lubricating any part of the defibrillator could damage it or diminish its performance.

Battery Capacity Test

The battery capacity test measures the current battery capacity. The battery capacity test should be performed after any of the following:

- After installing a new battery.

- After six months of service (more often if defibrillator use frequently depletes the battery without allowing time for full charge cycles).

- After the defibrillator has been stored for an extended period or each time the unit is opened.

The total time required to perform the battery capacity test is **about 30 hours**. The first part of the battery capacity test involves charging the battery for eight hours to ensure sufficient charge. Once started, the battery capacity test runs for about 3.5 hours. Because the battery capacity test discharges the battery, allow an additional 18 hours after the test to re-charge the battery to full capacity.

Testing the Battery Capacity

Follow these steps to perform the battery capacity test:

1 Charge the battery by plugging the instrument into AC power for eight hours. When you start charging the battery, verify that the (AC POWER) and (BATT CHRG) lights are on.

2 Verify that there is recorder paper in the recorder.

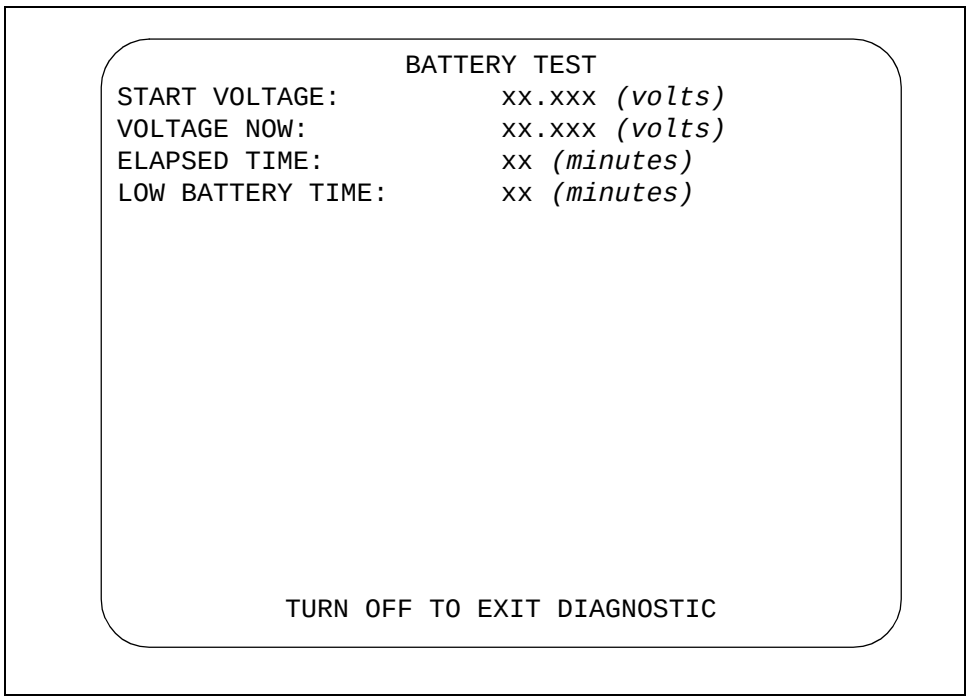
3 While pressing the (Sync) and (HR Alarm) keys, turn the Energy Select control from the **Off (Standby)** position to the **Monitor On** position. The setup/diagnostic menu appears after a moment.

4 Unplug the instrument from AC power (the (AC POWER) and (BATT CHRG) lights go off).

5 Press (▼ECG Size▲) to highlight TEST BATTERY.

6 Press (Lead Select) to start the Battery Capacity Test. The monitor displays the information shown in Figure 3-11.

Figure 3-11


BATTERY TEST
START VOLTAGE: xx.xxx (volts)
VOLTAGE NOW: xx.xxx (volts)
ELAPSED TIME: xx (minutes)
LOW BATTERY TIME: xx (minutes)
TURN OFF TO EXIT DIAGNOSTIC

Battery Capacity Test

START VOLTAGE:	**The battery voltage when the test started.**
VOLTAGE NOW:	**The battery voltage at the present time.**
ELAPSED TIME:	**The elapsed time since the test started. The time includes the** LOW BATTERY TIME**.**
LOW BATTERY TIME:	**The length of time that the battery has been below the low battery warning level.**

7 When the battery voltages reaches a low level, the Shutdown Warning tone sounds and the recorder prints out the final values of the displayed results just prior to turning off the instrument.

8 Replace the battery if the recorded value for ELAPSED TIME is less than 150 minutes (2.5 hours) or the value for elapsed LOW BATTERY TIME is less than 10 minutes.

9 Turn the Energy Select control to the **Off (Standby)** position.

10 Fully recharge the battery by plugging the instrument into AC power for 18 hours. Verify that the (AC POWER) and (BATT CHRG) lights are on.

11 The instrument is now ready to be returned to service.

Printing the System (Error) Log

When an error occurs during normal operation, an error code associated with the error is stored in memory in the error log. Selecting `PRINT LOG` in the setup/diagnostic menu prints the stored error log. To decipher an error code on the printout, refer to the error lists in Chapter 4, Troubleshooting. Store the error log printout with the defibrillator's permanent maintenance record.

When the printout is complete, you can select another test from the setup/diagnostic menu.

Care and Cleaning

The defibrillator and its accessories are chemically resistant to common cleaning solutions and non-caustic detergents. The following list includes some approved cleaning solutions.

• 90% Isopropyl alcohol (except adapters and patient cable)

• Soap and water

• Chlorine Bleach (30ml/l water)

NOTE

Keep the outside of the instrument clean and free of dust and dirt. Clean the paddles thoroughly to prevent build-up of dried electrolyte paste.

CAUTION

Do not allow any fluids to penetrate the instrument case. Avoid pouring fluid on the unit while cleaning.

Do not use abrasive cleaners, or strong solvents such as acetone, or acetone-based compounds.

Clean the display screen carefully. It is especially sensitive to rough handling and is subject to scratching.

Do not steam-sterilize the monitoring leads, submerge them for prolonged periods, or heat them above 50°C. If metallic surfaces become oxidized, clean them with a very light abrasive (toothpaste). Do not use highly abrasive cleaners, such as steel wool or silver polish.

Do not steam- or gas-sterilize the external paddle set.

For detailed information on cleaning and sterilizing the internal paddles, see the "Maintaining the Defibrillator" chapter in the *CodeMaster XL+ Defibrillator/Monitor User's Guide*.

Equipment List

Table 3-5 lists specifications that must be met by the equipment used to verify performance of the defibrillator. This equipment is commercially available.

Table 3-5 **Equipment List**

Equipment/Test	Specifications
Calibrated Leads ECG simulator (ECG simulation test)	±2% accuracy
Calibrated Paddles ECG simulator (ECG simulation test)	±2% accuracy
AAMI patient termination (ECG simulation test)	47 nF in parallel with 51 K ohms together in series with each lead wire.
Defibrillator test box	
(Delivered energy level test)	
Load resistance:	50 Ω ±1% (non-inductive)
Measurement range	
Maximum energy:	≥450 joules
Maximum voltage:	≥6000 V
Maximum current:	≥120 A
Measurement accuracy	
≥20 joules:	≤±2% of reading (damped sinusoidal waveform)
< 20 joules:	≤±0.4 joules (damped sinusoidal waveform)
Cardioversion measurement range:	–150 to +150 ms
Pacer tester	
Load impedance:	≤400Ω
Current measurement accuracy	
10 mA–50 mA:	< ±2 mA
50 mA–200 mA:	< ±4%
Rate measurement accuracy	
40–180 ppm:	< ±0.5%
Waveform duration accuracy:	±1ms

In addition, a test load is available for testing the external pads adapter (HP M1781A).

Performance Verification Checklist

Model number _____
Serial number _____
Test date _____
Test technician _____

Visual Inspection

Disconnect the defibrillator from AC power and inspect for the following:

- ☐ Loose or missing hardware.
- ☐ Frayed or damaged wiring.
- ☐ Mechanical damage.
- ☐ Evidence of liquid spill.
- ☐ Dirt on the thermal printhead
- ☐ Recorder roller wear.
- ☐ Wear or damage to power cord and associated strain relief.
- ☐ Corroded or damaged electrodes.
- ☐ Damaged adaptors or patient cables.

Connect the defibrillator to AC power and verify the following:

- ☐ The (AC POWER) and (BATT CHRG) indicators are lit
- ☐ The (Charge) and (Sync) indicators light momentarily, when you turn the Energy Select control to **Monitor On** to turn on the defibrillator.

Enter the data to record in the format V:x, where x is p (pass) or f (fail).
For example: V:p. _____

Calibration Test

- ☐ Calibrate Defibrillator

Enter the data to record in the format C:x, where x is p (pass) or f (fail).
For example: C:p. _____

Defibrillator Test

(Conduct these tests in setup/diagnostic mode)

Using only battery power, set Energy Select to 100; test the following:

- ☐ Msec. to charge—aaaa
- ☐ Delivered Energy—bbb
- ☐ Impedance—cc
- ☐ Peak Current—dd

Using only battery power, set Energy Select to 360; test the following:

- ☐ MSec. to charge—eeee
- ☐ Delivered Energy—fff
- ☐ Impedance—gg
- ☐ Peak Current—hh

Using AC power (battery removed), set Energy Select to 360; test:

- ☐ MSec. to charge—iiii
- ☐ Delivered Energy— jjj
- ☐ Impedance—kk
- ☐ Peak Current—ll

- ☐ Disarm Test—m

Enter the data to record in the format DT:aaaa,bbb,cc,dd,eeee,fff,gg,hh iiii,jjj,kk,ll,m. For example: DT:1300,100,50,30,3600,360,50,55,12000,360,50, 55,p. _____

ECG Tests

- ☐ Leads Status, Paddle Status, and DSP Status—x
- ☐ DC Offset—aaa
- ☐ PCI Calibration

  o paddles shorted—e

  o paddles in pocket—fff

Enter the data to record in the format E:x,aaa,e,fff. For example: E:p,0,1,60. _____

Auxiliary Function Tests

- ☐ CRT Test
- ☐ Recorder Test
- ☐ Controls Test
- ☐ Indicator Test

Enter the data to record in the format A:x, where x is p (pass) or f (fail).
For example: A:p. _____

Pacer

- ☐ Pacer Test (Option installed)
  - ☐ Selected Output set to 40mA—aa
  - ☐ Selected Output set to 100mA—bbb

Enter the data to record in the format PT:aa,bbb. For example: PT:40,99.

_____

Parameter Function Tests

- ☐ SpO_2Test (Option)
- ☐ HR Alarm Test
- ☐ ECG Simulation Test
- ☐ Synch Cardioversion Test
  set unit to sync mode, check if defibrillator fires in synch

Enter the data to record in the format F:x, where x is p (pass) or f (fail).
For example: F:p. _____

Safety Tests

- ☐ Chassis-to-Ground Resistance Test—aaa
- ☐ Ground wire Leakage Current Test—bbb
- ☐ Enclosure Leakage Current Test—ccc
- ☐ Patient Lead Leakage Current Test

  o To Ground—dd

  o Between patient leads—ee

  o With line voltage applied—ff

Enter the data to record in the format S:aaa,bbb,ccc,dd,ee,ff; for example:
S:09,400,90,77,16. _____

Note: When recording test results, separate tests by a semi-colon(;). For example: V:p;C:p;DT:1300,100,50,30,3600,360,50,55,p;E:p,0,1,60;A:p;PT:40,99;F:p; S:09,400,90,7,7,16

Print out the system (error) log. Store the printout with the defibrillator's permanent maintenance record.

Print out the setup menu settings. Store the printout with the defibrillator's permanent maintenance record.

Comments:

Troubleshooting

Introduction

This chapter provides information for localizing defibrillator/monitor problems to the assembly level. This troubleshooting information is designed for use with the defibrillator's setup/diagnostic tests to efficiently repair the defibrillator with a minimum of equipment.

Maintenance Philosophy

The repair philosophy for the defibrillator is assembly replacement. Replaceable assemblies are identified in Chapter 6, **Parts Lists**.

CAUTION

Individual component replacement should not be attempted outside of an authorized HP repair facility. Component level repair is extremely difficult due to the extensive use of surface mount technology and the high parts-density on the circuit boards. Unauthorized component replacement can impair defibrillator performance.

Troubleshooting Guide

The following information suggests ways of using the information in this manual to troubleshoot defibrillator failures.

Verify the Failure

Before troubleshooting the defibrillator, make sure that the failure is not the result of improper use. See the *CodeMaster XL+ User's Guide* for a condensed description of controls and their use.

The built-in diagnostic tests are useful for verifying some failures. See "Using Setup/ Diagnostic Tests in Troubleshooting" on page 4-2 for a description of these tests.

Check the Error (System) Log

Print the error log to see if it contains an error code. You can clear the error log, operate the defibrillator and repeat the failure, and then print the error log to see if the failure created a new error code. See "The System Log" on page 4-4 for detailed information on error codes.

Using the Troubleshooting Tables

Check to see which functional areas of the defibrillator are affected. The troubleshooting tables organize symptoms by type: audible, displayed, and symptoms specific to a functional area of the defibrillator.

In the tables, find the symptoms that apply to the instrument failure.

Try the solutions suggested in the tables for the symptoms of your defibrillator.

Before replacing parts, check that cables and connectors are seated, check that boards are seated and look for damaged parts.

In the tables, replace the first board listed, since the board most likely to fail is usually listed first. Verify that the failure still exists; then, replace the next board listed.

After repair, verify that the defibrillator operates to specification. See “Verification after Repair” on page 4-2 for detailed information.

Using Setup/Diagnostic Tests in Troubleshooting

The setup/diagnostic tests are built-in, menu-driven tests that can quickly check defibrillator operation without the use of additional equipment. The tests check these functional areas:

Defibrillator Test	Checks defibrillator charging and verifies post shock data (Ipeak, delivered energy and patient impedance)
ECG (monitor) Test	Verifies monitor operation
CRT Test	Displays a test pattern
Recorder Test	Prints a test strip
Controls Test	Allows you to verify keypanel operation; on-screen indication gives direct feedback when a key is pressed
Indicators Test	Cycles the keypanel indicators so that you can verify LED operation; tests the CRT Alert tones.
Battery Test	Checks battery charge capacity

Instructions for entering and using setup/diagnostic mode are found in Chapter 3, **Performance Verification and Maintenance**.

Verification after Repair

After repairing the defibrillator, perform the tests described in Chapter 3, **Performance Verification and Maintenance**, to verify operation of the defibrillator to specifications. In addition, perform the defibrillator calibration and the defibrillator test in the built-in menu tests; see Chapter 2, **Setup and Configuration**, for test descriptions.

Test Equipment

The following test equipment is required to troubleshoot the defibrillator as described in this chapter. This equipment is all commercially available.

- A digital voltmeter such as the HP E2373A handheld multimeter.
- 12-lead ECG simulator.
- Pacer tester.
- Energy meter.
- Paddles ECG simulator (built into many manufacturers energy meter).
- SpO2

Safety Considerations

WARNING

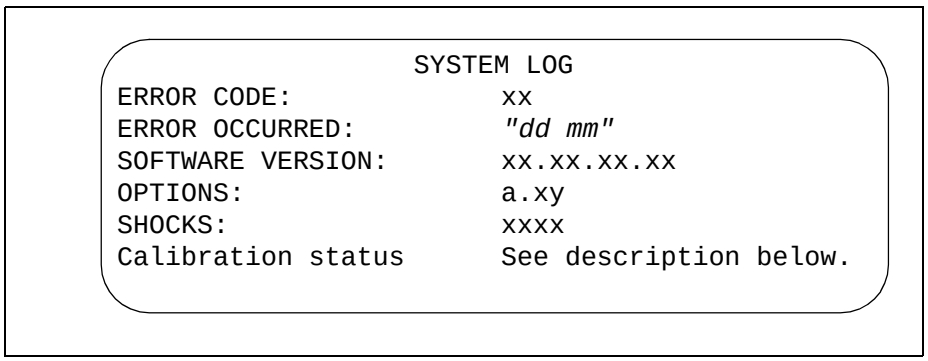
- **To remove power from the instrument, you must turn the Energy Select control to *Off (Standby)*, unplug the instrument from AC power, and remove the battery. Disconnecting the unit from AC power will not remove power because the battery powers the instrument while AC power is unavailable.**

- **To disarm a charged instrument, there are three methods:**
  - **Turn the Energy Select control to the *Off (Standby)* position.**
  - **Place the paddles in their holders on the defibrillator, and depress both shock buttons on the paddles.**
  - **In manual mode, After 60 seconds, the unit automatically disarms. In shock advisory mode, after 60 seconds, the unit automatically disarms.**
- **Before removing or inserting any board or connector, disconnect the instrument from AC power, and remove the battery.**
- **The defibrillator stores high voltage energy and is capable of delivering up to 360 joules of DC energy to a 50 ohm impedance.**

The System Log

The system log is battery-maintained memory that stores error codes for the last error event that the instrument detected. In addition, the system log contains software version and instrument option information. The system log can be printed by entering the setup/diagnostic menu and selecting `PRINT LOG` as explained in Chapter 3, **Performance Verification and Maintenance**. See Figure 4-1.

Figure 4-1



System (Error) Log Format

`ERROR CODE:`	The error code of a run-time error.
`ERROR OCCURRED:`	The date and time that the error occurred according to the system clock.
`SOFTWARE VERSION:`	The software version of the firmware installed in the defibrillator; the version line has the following format: `Monitor code revision.Reserved.DSP code revision.Defib code revision.`
`OPTIONS:`	a code in the form of: a.xy a = instrument, 0 = M1722A/B, 1 = M1723A/B For an M1723A/B the second option number is always 0

X	Activate	where:
0	Nothing	A = EMS ECG
1	P.P.	AG = Auto Gain
2	FV	FV = Feature Vector*
3	PP & Vector	PP = Pace Pulse
4	AG	
5	AG & PP	
6	AG & FV	
7	AG & FV & PP	
8	A	
9	A & PP	
A	A & FV	
B	A & FV & PP	
C	A & AG	
D	A & AG & PP	
E	A & AG & FV	
F	A & AG & FV & PP	

Y	Activate	where:
0	Nothing	P.Pr = Pacer Present
1	P.Pr.	SpO_2
2	SpO_2	
3	P.Pr. & SpO_2	

*FV = Feature Vector is also called "Measurement Matrix."

NOTE

EMS filter and Measurement Matrix set up features are software revision dependent (software revision: 57.00.52.33).

To activate these features, press the following keys: highlight "**Setup Menu 1**", press the "Select" key, then press simultaneously:

Pace Pulse (SYNC) (HR Alarm) (Mark)

Measurement Matrix (SYNC) (Analyze)

To activate these features, press the following keys: highlight "**Setup Menu 2**", press the "Select" key, then press simultaneously:

Auto Gain (SYNC) (HR Alarm)

EMS ECG (SYNC) (Mark)

SHOCKS:	The number of shocks since the shock counter was last reset.
Calibration status:	This area will contain one of these: • CALIBRATION PASSED dd mmm yy—The last defibrillator calibration (on the date shown) was successful. • CALIBRATION FAILED dd mmm yy —The last defibrillator calibration (on the date shown) failed; the defibrillator will still function but charge energy levels may not be accurate (the defibrillator will use a nominal value for the charge capacitor). • CALIBRATE DEFIB—The defibrillator has not been calibrated or the calibration value has been lost. The defibrillator will still function but charge energy levels may not be accurate (the defibrillator will use a nominal value for the charge capacitor).

Error Codes

Table 4-1 describes the errors that can appear in the error log and suggests solutions.

NOTE

Replace the board assemblies in the order shown. After replacing a board assembly, check to see if the problem has been resolved. If the problem is still present, replace the next board assembly listed. When the instrument is working properly, clear the error log. See “Clearing the Error Log” on page 4-9 for detailed information.

If more than one defibrillator error occurs, the codes for those errors are summed and printed in hexadecimal form. The hexadecimal sum of any combination of these error codes yields a unique number. For example, an error code of 0AC can only be formed by the sum of error codes 080, 020, 008, and 004.

Table 4-1 **Error Codes**

Error Code	Error Description	Possible Solution
001	The HV capacitor charges at less than 6 joules/second	1 Replace high voltage board. 2 Replace control board. 3 Replace HV capacitor.
002	The HV capacitor charges to more than 120% of the desired voltage.	1 Replace control board. 2 Replace high voltage board.
004	Unexpected drop in HV capacitor voltage.	1 Replace high voltage board. 2 Replace control board. 3 Replace HV capacitor.
008	Unexpected voltage on HV capacitor	1 Replace high voltage board. 2 Replace control board.
010	The safety relay has failed.	1 Replace high voltage board. 2 Replace control board.
020	The supply voltage is outside the nominal range.	1 Replace power supply. 2 Replace control board.
040 400 440	A patient relay drive failure was detected.	1 Check patient relay coil resistance. If outside nominal range, (3 ohms ± 1 ohm) replace patient relay. 2 Replace high voltage board. 3 Replace control board.
080	A power-on failure has occurred.	Replace control board.
100	Defibrillator control firmware failure has occurred.	1 Send error log and description of failure to the factory. 2 Cycle power. If problem persists, replace control board.
Monitor Codes:	1xxxx	For most monitor error codes, the cause is probably the control board.
10001	Monitor firmware failure has occurred.	1 Send error log and description of failure to the factory. 2 Cycle power. If problem recurs, replace control board.
10002	Defibrillator timeout (does not return shock information).	1 Send error log and description of failure to the factory. 2 Cycle power. If problem recurs, replace control board.
10003	Defibrillator timeout (does not accept configuration).	1 Send error log and description of failure to the factory. 2 Cycle power. If problem recurs, replace control board.

Table 4-1 Error Codes

Error Code	Error Description	Possible Solution
10004	Defibrillator timeout (does not accept ECG data).	1 Send error log and description of failure to the factory. 2 Cycle power. If problem recurs, replace control board. 3 Replace front end board.
10005	Clock timeout (Time-Out-Done clock is not ready).	Replace control board.
10006	Reserved	
10007	Reserved	
Front End Codes:	2xxxx	
20001	Sequential data error	Cycle power. If problem recurs, replace front end board.
20002	Total data error	1 Replace front end board. 2 Replace control board.
20003	DSP timeout (Back-up Timer interrupt).	Replace control board.
20004	Front end hard failure.	Replace front end board.
Pacer Codes:	3xxxx	
30001 30002 30003 30004 30005	Pacer failure.	1 Change pads and check pads adapter cable. 2 Cycle power on instrument. 3 Restart the pacer. If error reoccurs, 4 Replace pacer board. 5 Replace the control board.
Processor Codes:		
40001-40009	Control board failure.	Replace control board.

Table 4-1 **Error Codes**

Error Code	Error Description	Possible Solution
SpO_2 Codes:	5xxxx	
50006	The SpO_2 sensor is broken.	Attach new sensor and cable.
50009	Unable to communicate with the dual-port RAM.	1 Cycle SpO_2 power. 2 Replace SpO_2 board.
5000A	Hardware failure on the SpO_2 module.	1 Cycle SpO_2 power. 1 Replace SpO_2 board.
5000B	The SpO_2 module processing units cannot communicate.	1 Cycle SpO_2 power. 1 Replace SpO_2 board.
5000D	Software problem in the SpO_2 module.	1 Cycle SpO_2 power. 1 Replace SpO_2 board.
5000E	The monitor cannot communicate with the SpO_2 module.	1 Cycle SpO_2 power. 1 Replace SpO_2 board.

If an error repeats, use the appropriate setup/diagnostic test to help locate the failure. The setup/diagnostic tests are described in Chapter 3, **Performance Verification and Maintenance**.

Clearing the Error Log

After servicing the defibrillator/monitor, it is **important to reset (clear)** the error log. This process clears the entries for ‘‘Error Code" and ‘‘Error Occurred".

To clear the error code from the error log, follow these steps:

1 Place the defibrillator in diagnostic mode.

2 On the setup/diagnostic menu, move the highlight bar over `PRINT LOG`.

3 Press the (Sync) and (HR Alarm) keys simultaneously.

Turn the Energy Select control to the **Off (Standby)** position, to exit the setup/diagnostic menu.

Troubleshooting Tables

The troubleshooting tables in this section help you to locate a fault and correct it. The following tables list errors and failure symptoms that can occur at power on, during normal operation, or as a result of setup/diagnostic tests. The tables define and explain the errors, and suggest one or more corrective actions for each.

The troubleshooting tables include the following:

Table 4-2	Describes tones made by the defibrillator.
Table 4-3	Explains system-level messages that the defibrillator can display.
Table 4-4	Describes displayed messages indicating defibrillator/monitor failures.
Table 4-5	Describes displayed messages that indicate pacer malfunction.
Table 4-6	Describes displayed messages that indicate a malfunction of the pulse oximeter.
Table 4-7	Describes failure messages that the recorder can print.
Table 4-8	Lists indications of improper use.
Table 4-9	Describes indications of power supply or main battery failures.
Table 4-10	Lists recorder problems and their symptoms.
Table 4-11	Lists symptoms display and logic failures.
Table 4-12	Describes keypanel failures and their symptoms.
Table 4-13	Describes defibrillator problems and their symptoms.
Table 4-14	Describes pacer problems and their symptoms.

Table 4-2 **Audible Indicators**

Tone	Cause	Possible Solutions
While all keypanel LEDs are lit, a beep about 1 second long.	At power-on, indicates power-on cycle is normal.	None required.
A continuous beep, about 7 seconds long.	At power-on, the monitor and defibrillator are not communicating.	The malfunction is probably in the monitor circuits; the defibrillator may still function properly. Replace the control board as recommended in Table 4-4.
A repeating tone that alternates between two frequencies.	At any time, the instrument emits this tone beginning 1 minute before shutdown due to low battery charge. The battery voltage is less than 11.4 V The battery voltage is too low and the battery does not recharge.	Connect the instrument to AC power so that the battery can recharge. Check the battery cable connections to the high voltage board. Check the battery capacity by running the “Battery Capacity Test” on page 3-28.

NOTE

Other tones normally occur because various functions are enabled. See “Auxiliary Function Tests—Indicator Test” on page 3-22 for descriptions of these tones.

Table 4-3 **On-screen System Messages**

Message	Possible Solution
DEFIB FAILURE	Troubleshoot defibrillator subsystems. Check Error Log and troubleshoot per error code.
MONITOR FAILURE	1. Replace front end board. 2. Replace control board.
PACER FAILURE	Replace pacer board.
SPO2 FAILURE	1 Cycle SpO_2 power. 2 Replace SpO_2 board.
SYSTEM FAILURE	Replace control board.

Table 4-4 **On-screen Defibrillator/Monitor Messages**

Message	Cause	Possible Solutions
50J MAX	Internal paddles are attached and the Energy Select control has been turned past 50 joules.	Defibrillator will automatically limit the charge to 50 joules (internal paddles limit). For a higher charge level, use external paddles or pads.
	Pads Adapter Cable	Replace the Pads Adapter Cable
CHECK RECORDER (3 seconds)	The recorder door is open, or the recorder is out of paper.	Close the recorder door or replace the paper roll (see Chapter 4).
DEFIB DISARMED (3 seconds)	Defibrillator has internally discharged energy and is now disarmed.	Defibrillator normally disarms after holding the charge level for about 60 seconds in Manual Mode and 30 seconds in Shock Advisory Mode. Press (Charge) to charge to the selected energy level.
LEADS OFF displayed on screen (3 seconds).	Loose or defective patient cable, cable connectors.	Check cable and connectors for damage. Tighten connectors as necessary. Replace damaged or defective cable.

Table 4-4 **On-screen Defibrillator/Monitor Messages**

Message	Cause	Possible Solutions
LEADS OFF not indicated when wire is off.	Dirty contacts on connector for leadwires.	Ensure the contacts on the connector are clean and dry.
	Defective or dirty leadwire.	Clean and swap around to isolate defective leadwire. Replace defective leadwire.
	Pads Adapter Cable	Replace Pads Adapter Cable
LEADS OFF indicated (3 seconds) when wire is not off.	Poor electrode contact.	Improve patient preparation.
	Defective leadwire.	Remove leadwire and install shorting plug.
LOW BATTERY	Defibrillator is not connected to AC power and the battery voltage is below 11.8 volts DC.	Connect the unit to AC power.
	Message remains with AC power applied and AC POWER LED is lit.	Troubleshoot power supply or battery. See Table 4-9.
	Message remains with AC power applied and AC POWER LED is not lit.	Do each as necessary: 1 Check power cord. 2 Check power supply AC connections and cable to control board. 3 Replace power supply. 4 Replace control board.
NO PADDLES	Paddle set is not connected to the defibrillator.	Attach external paddles, internal paddles, or pads adapter as required.
	Paddles set is attached, but connector lock is not in **lock** position.	Push paddle connector lock to the **lock** position.
	Paddles set is properly attached, but the paddles set is defective.	Replace paddles set.
SETUP LOST	The memory that stores the setup has been corrupted. Perform only the steps required to resolve. Check after each step.	1 Restore setup by changing a parameter. Then verify that the SETUP LOST message is gone. 2 Replace control board. Reinstall battery; do not connect AC power. Turn on instrument and change a setup parameter. Verify that the SETUP LOST message is gone. 3 Replace lithium battery. Reinstall main battery; do not connect AC power. Turn on instrument and change a setup parameter. Verify that the SETUP LOST message is gone.

Table 4-4 **On-screen Defibrillator/Monitor Messages**

Message	Cause	Possible Solutions
USE LEADS	Paddles are connected to the defibrillator and:	
	1. (Sync) was pressed when PADDLES was selected.	1. Use PADS or select LEAD I, II, or III instead of PADDLES. Press (Sync) to remove the defibrillator from sync mode.
	2. Defibrillator is in sync mode and PADDLES is selected.	2. Use PADS, or select LEAD I, II, or III instead of PADDLES.
	3. Defibrillator is in Defib mode and PADDLES selected when leads are attached to the patient.	3. Use PADS or select LEAD I, II, or III instead of PADDLES.

Table 4-5 **On-screen Pacer Messages (Option installed)**

Message	Cause	Possible Solutions
ATTACH PADS	Pads adapter cable is attached. (Charge) was pressed and pads are not attached. (Pacer On) was pressed and pads are not attached.	Attach the pacer pads.
NO PADS	Pacer is on and one of the following occurs: 1 No pads adapter attached. 2 Paddles attached. 3 Internal paddles attached. 4 Defective Pad Adapter Cable	Attach pads for pacing. Replace Pad Adapter Cable
PACER FAILURE	Pacer cannot deliver the required current.	Troubleshoot pacer.
PADS OFF	Pads adapter cable is attached and a pad is off. High DC Offset voltage. Defective Pads Adapter Cable	Attach pads for pacing. Wait for DC Offset bleeding, up to 3 minutes. Replace Pads Adapter Cable
STOP PACER	An attempt was made to change pacing mode while pacing.	Stop the pacer (press (Start/Stop)) before you change the pacing mode.

Table 4-6 **SpO_2 Messages (Option)**

Message	Cause	Possible Solutions
SPO2 FAIL-URE	The unit detected a failure in SpO_2 subsystem hardware. This failure does not affect other parts of the instrument.	Press (SpO_2 On/Off) twice to power cycle the SpO_2 option. If the error happens again, call for service.
SPO2 SEN-SOR FAIL	The sensor or adapter cable is broken.	Replace the sensor or adapter cable.
SPO2 CABLE OFF	Sensor or cable is disconnected.	Check SpO_2 connections between defibrillator/monitor and the sensor cable or adapter cable.
Dashes appear on display instead of SpO_2 reading.	Can't derive measurement because: • The sensor is not on the patient. • No pulse is detected. • The sensor is incorrectly positioned. • The sensor is defective.	Check the patient for a pulse. Reapply the sensor, and make sure it is correctly positioned. If it doesn't work, replace the sensor.
SPO2 NOISY SIGNAL	Irregular pulse patterns. Patient motion.	Reapply sensor. Consider using a different sensor site.
SPO2 LIGHT INTERF	Too much interference from external light. Damage to sensor or adapter cable.	Reapply sensor. Turn off lights in the room. If other options do not work, replace the sensor.
SPO2 LOW SIGNAL	Bad connection to patient, or patient has poor perfusion.	Check the patient for poor perfusion. Reapply disposable and semi-disposable sensors. Readjust reusable sensors. Consider using a different sensor site.

Table 4-7 **Printed Failure Messages**

Message	Possible Solutions
TEST 100J FAILED	Defib test failure: delivered energy check failed or the Shock Path Redundancy test failed. Print Error Log and troubleshoot per error code. Wait 2 to 3 seconds after Power-On to press the "Charge" button. This will allow the Power-On's subroutine test to complete and identify the paddles in their cradles. Perform PCI Calibration. The external paddle sets are not recognized in the side pocket by the unit. Seat the paddle sets firmly. Bend out the bracket in the side pocket to improve contact. Replace the adult adaptor. Swap the adult adaptor between the Apex and Sternum paddle. Use an abrasive eraser to clean the contact surface of the adult adaptor and the bracket in the cradle.

Table 4-8 **Operation Problems**

Symptom	Cause	Corrective Action
Noisy lead(s): Muscle artifact.	Patient is not relaxed or skin has been irritated.	Refer to user's guide.
	Low quality disposable electrodes, leadwire adapters.	Replace disposable electrodes or leadwire adapters.
	Defective leadwires.	Isolate defective leadwires and replace them.
	Noisy ECG amplifier	Test with ECG simulator. Use diagnostic test, "ECG Tests" on page 3-14. Replace front end board.
Noisy trace on paddles, paddles in pockets.	Bad paddle contact.	1 Clean paddles and paddle contacts. 2 Replace ECG front end/pacer board. 3 Replace internal test load resistor.
Failed synchronized cardioversion with internal monitor test.		Replace control board.

Table 4-9 **Power Supply and Battery**

Symptom	Cause	Corrective Action
(AC POWER) indicator is not lit.	No AC power.	Check power cord, AC fuses on power supply board, and connectors.
	AC-on indication failed.	1 Replace power supply. 2 Replace control board.
	Power supply failed.	Replace power supply.
(BATT CHRG) indicator is not lit. ((AC POWER) indicator is lit.)	Battery is not installed.	Install the battery; check the connector.
	Battery sense circuit failed.	1 Replace high voltage board. 2 Replace control board.
Defibrillator will not power up on AC or battery power.	Power supply defective.	Replace power supply.
	Control board defective.	Replace control board.

Table 4-9 **Power Supply and Battery**

Symptom	Cause	Corrective Action
Defibrillator will operate on AC but not battery power.	Battery fuse is blown.	Replace battery fuse on battery connector board.
	Battery voltage is too low.	1 Plug defibrillator into AC power to charge battery. 2 Perform battery capacity check. 3 Replace battery if the test fails.
Battery voltage is less than 11.4 volts.	Battery needs charge.	1 Plug defibrillator into AC power to charge battery. 2 Perform battery capacity check. 3 Replace battery if the test fails.
Battery will not accept charge.	Battery is defective.	Replace battery.
	Battery charger failed.	Replace power supply.

NOTE

The diagnostic screen, TEST BATTERY, will provide the following information:

`NO BATTERY`	Appears if the battery is not installed, or if the unit does recognize that the battery is installed.
`DISCONNECT AC POWER`	Appears if the unit recognizes AC power is connected.

Table 4-10 **Recorder Problems**

Symptom	Cause	Corrective Action
Paper doesn't move.	Paper out or jammed.	Replace paper or clear paper jam.
	Defective sensor.	Replace recorder board or recorder assembly.
	Defective drive assembly.	Replace drive assembly or recorder assembly.
	Defective drive signals.	Replace Control Board.
	Dirty sensor lens.	Clean sensor lens.
	Defective communication between recorder board and motor.	Check motor to recorder board cable connector.

Table 4-10 Recorder Problems

Paper moves, then stops.	Paper loaded incorrectly.	Make sure defibrillator is loaded properly with approved thermal paper.
	Dirty sensor lens.	Clean sensor lens.
	Defective sensor.	Replace recorder board.
	Defective sensor circuit.	Replace control board.
Wavy diagonal lines in recorder self-test or distortion of printouts in the time axis.	Improper meshing of gears in drive assembly or door assembly.	Replace recorder drive assembly or door assembly. Replace control board.
	Defective communication between recorder and control board.	Replace control board.
Message: CHECK RECORDER	Door is ajar.	Close door.
	Paper installed incorrectly.	Re-install paper.
	Dirty sensor lens.	Clean sensor lens.
	Defective communication between recorder and control board.	Check cables and connections between recorder and control board.
		Replace recorder assembly.
		Replace control board.
	Defective sensor assembly.	Replace recorder board.
Paper moves but printing is faint or absent.	Door improperly latched.	Check door latch.
	Paper loaded incorrectly, or non-approved or non-thermal paper installed.	Make sure defibrillator is properly loaded with approved thermal paper.
	Insufficient leaf spring tension or printhead out of position.	Check leaf spring on printhead for platen pressure.
	Defective printhead or printhead cables.	Check printhead cable connector. Replace printhead.
	Defective recorder board cable connector or component in recorder interface circuitry.	Check the recorder board cable connector. Replace control board.
Printed data is garbled.	Defective printhead.	Replace printhead or recorder assembly.
	Defective component in data path.	Check printhead cables. Replace control board.

Table 4-10 Recorder Problems

Poor print quality or some dots not printing.	Dirty printhead.	Clean printhead.
	Defective printhead or printhead cables.	Check printhead cable connector or replace printhead.
	Defective component in recorder circuitry.	Replace recorder assembly.
Some dots always on.	Defective printhead.	Replace printhead or recorder assembly.

Table 4-11 Display and Logic

Symptom	Cause	Corrective Action
Display too dim or too bright.	Improper brightness adjustment.	Adjust brightness controls for best display appearance. See CRT adjustment procedure.
No brightness adjust.	Defective display assembly	Replace display assembly.
All dark screen.	Contrast or brightness misadjusted.	Adjust contrast.
	Deflection circuits failed or video circuits failed.	1. Replace display board. 2. Replace control board.

Table 4-12 Panel Keys

Symptom	Cause	Corrective Action
Keys won't work.	Keypanel board cable unplugged or defective.	Reconnect or replace cable.
	Keypanel circuit board defective.	Replace keypanel board or assembly.
	control board defective.	Replace control board

Table 4-13 Defibrillator Problems

Symptom	Cause	Corrective Action
No response to Charge key.	Paddles cable not installed.	Install cable.
	Lockout Error (DEFIB FAILURE)	For error code, perform, PRINT LOG in Diagnostic screen. Replace control board, high voltage board, or high voltage components as recommended in Table 4-1.
	Charge key not recognized.	Run Controls Test to check for recognition of Charge key. Replace paddles, front panel, control board as needed.
Delivered Energy out of specification.	Improper defibrillator calibration.	Perform diagnostic test CALIBRATE DEFIB.
	Defective High Voltage Board.	Replace high voltage board.
	Defective control board.	Replace control board.
	Defective HV capacitor	Replace HV capacitor.
Test Discharge indicates a failure, external defibrillator test passes.	Internal delivered energy out of calibration.	Calibrate the Peak Current Measurement circuitry as described in "Adjusting the Internal Delivered Energy Calibration" on page 5-30.
	Defective Control Board.	Replace Control Board.
DEFIB FAILURE At power up or after a discharge.	Patient relay or drive circuit failure (Error 40 or 440). See warning below. Unexpected voltage on HV capacitor.	Replace patient relay. Replace high voltage board. Replace HV board.
Unit does not deliver energy, no failure message occurs.	Patient Relay failure.	Replace Patient Relay.

WARNING

The high voltage storage capacitor can store lethal amounts of energy. Be sure that this capacitor is discharged before touching high voltage components, such as the high voltage capacitor, patient inductor, patient relay, or patient cable connector. To discharge the high voltage capacitor:

1. **Be sure to wear safety glasses while discharging the capacitor.**
2. **In diagnostic mode make sure that the Available Energy is 0 (the Energy Select control is in the Monitor--On position).**
3. **Turn the Energy Select control to Off (Standby).**
4. **Wait 30 seconds before opening the unit.**
5. **After accessing the chassis as described in step 1 below, short the terminals of the high voltage capacitor. Wait one hour before servicing the unit. You can then proceed using a screwdriver with an insulated handle to short the capacitor terminals.**

Table 4-14 Pacer Problems

Symptom	Cause	Corrective Action
QRS not detected	QRS is not in specs	These specs are: QRS amplitude: 0.5 mV - 5.0 mV RS width: 40 mSec - 120 mSec
	AutoGrain setup	Increase ECG gain
	Pacer is in Fix Mode	Change pacer to Demand Mode
Heart is not captured	Output current is too low	Increase output current until heart is captured. This occurs between 50 mA - 200 mA.
	Pacer HR is below instransic HR	Adjust Pacer HR at desired value
	Misplacement of pads	Reposition the pads
3 Beeps	Can not deliver pacing current	Replace Pads Adapter Cable
Can not pace	Display messages - - Paddle - - Internal Paddle	

Testing the Power Supply

Use this procedure to check the voltages produced by the power supply. All the voltage measurements are made on the control board, connector J12, and are taken with respect to ground.

WARNING

When the defibrillator is connected to AC power, there are dangerous voltages on the line module terminals. Do not touch any of the exposed connectors.

The HV capacitor stores hazardous amounts of energy during AC and battery operation. Be careful not to touch any of the exposed capacitor connections.

Make measurements on battery only. Plug into AC power only if the battery is too low to operate the defibrillator.

1 Remove the top cover as described in Chapter 5, **Removal and Replacement**

CAUTION

Be very careful not to short test points to ground or to other pins. This can result in defibrillator/monitor failure.

2 Locate connector J12 on the control board.

3 Check that the voltage at pin 27 is +4.3V ±0.4V.

4 Check that the voltage at pin 29 is +5.1V ±0.25V.

5 Check that the voltage at pin 31 is +12V ±0.6V. The presence of these voltages confirm the proper operation of the power supply.

6 Re-install the top cover.

7 Check AC/DC converter/ battery charger in the following steps:

a. Remove the battery from the instrument.

b. Connect AC power.

c. From the diagnostic menu, run the TEST BATTERY test.

d. Observe VDC on the test screen by reading the voltage from the line labelled `VOLTAGE NOW`.

e. Check that VDC = 13.6 V ±0.6 V.

NOTE

This measurement must be made at room temperature (20°C to 25°C). VDC is the battery charge voltage (float voltage), and is temperature compensated. This measurement must be made with the battery removed as VDC is set by the condition of the battery.

Removal and Replacement

Introduction

This chapter provides procedures for removing and replacing these defibrillator assemblies:

- The battery
- The recorder
- The keypanel assembly
- The pacer keypad assembly
- The CRT assembly and SpO_2 board
- The pacer board
- The control board
- The power supply assembly
- The high voltage charger and relay assembly
- The high voltage capacitor
- The patient inductor
- The ECG front end board
- Replacing the lithium battery
- Replacing fuses

This chapter also provides procedures for adjusting the CRT after maintenance.

WARNING

Dangerous voltages may be present on components and connections during instrument disassembly. Use extreme caution while the instrument cover is removed.

NOTE

The way that wires and cables are routed and dressed inside the chassis plays an important part in reducing electromagnetic and radio frequency interference emitted by the defibrillator. When you disassemble any part of the defibrillator, pay special attention to how cables and wires are routed. When you reassemble the defibrillator, be sure to route and dress all cables and wires as they were originally.

Tool Requirements

You will need the following tools to perform the procedures given.

- T10 and T15 drivers (or Torx driver kit, HP part no. 5181-1933)
- 5/16" nutdriver
- insulated flat-tip screwdriver
- long-nose pliers with insulated handles (for discharging the CRT)
- Small ruler with a centimeter scale (for CRT adjustments)
- CRT adjustment tool, HP part number 8710-1355

CAUTION

Be sure to work in a static-free environment. Use an electrostatic wrist band. The work surface and area surrounding it must be static-free.

Removing the Battery

Perform the following procedure to remove the battery.

WARNING

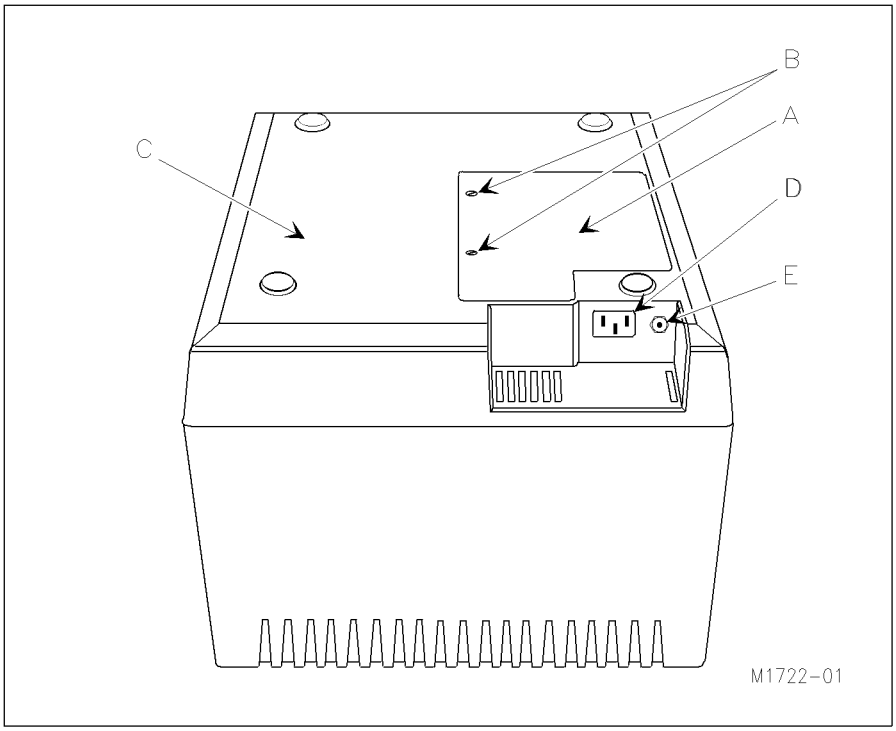
To avoid electrical shock hazard, unplug the power cord from the AC outlet now.

1 Turn off the instrument.

2 Turn the defibrillator upside down on the workbench. The battery compartment door is located in the bottom of the unit. Using a flat-tip screwdriver, turn the two screws 1/4-turn counter-clockwise to release the door. See Figure 5-1.

3 Disconnect the battery cable and lift the battery from the unit.

Figure 5-1



Accessing the Battery

A. Battery compartment door.
B. Retaining screws ($\frac{1}{4}$ turn).
C. Bottom side of defibrillator.
D. AC power receptacle.
E. Equipotential connector.

Opening the Defibrillator Chassis

Perform the following procedure to open the defibrillator chassis.

WARNING

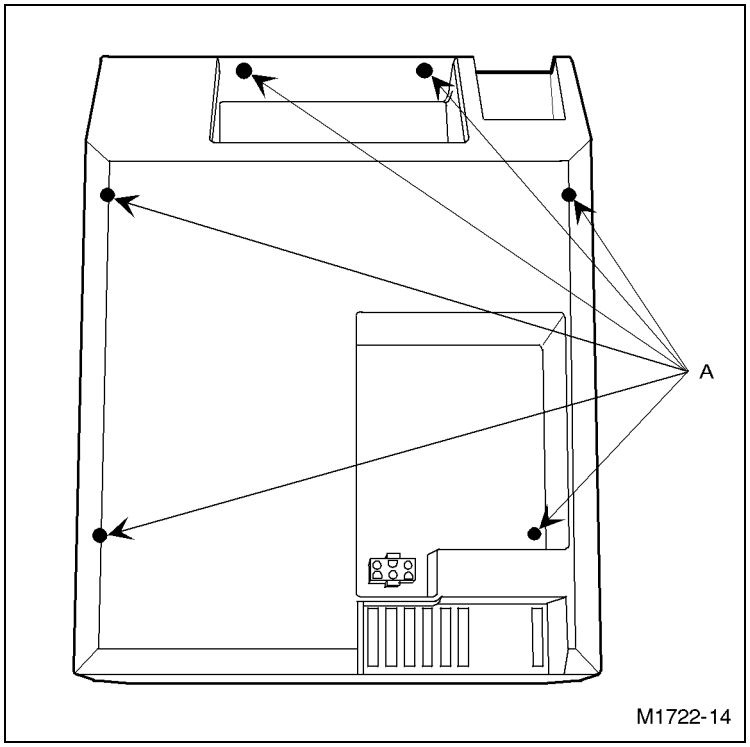
Before disassembly, check the defibrillator charge. Using the "Defibrillator Test" on page 3-11, verify that the available energy is zero.

1 Remove the paddles and the paddles connector.

2 Perform the procedure “Removing the Battery”.

3 Using a Torx T-15 screwdriver, remove the six screws that secure the upper and lower parts of the chassis. See Figure 5-2.

Figure 5-2



Opening the Defibrillator Chassis

A. Location of chassis screws

4 Turn the chassis upright. This will cause the six screws to fall out of the chassis. Perform this step slowly to avoid losing the screws. Grasp the handle securely and slowly tilt the chassis onto its back, and then onto its feet. Collect the screws and save for reassembly.

CAUTION

Be careful when opening the top cover; ribbon cables and ground wires connect the top and bottom parts of the chassis.

5 While facing the front of the instrument, partially open the top-right of the chassis. If the instrument is equipped with the pacer option, disconnect the cable assembly attached to the right-most connector on the control board, just beneath the CRT. Open the chassis top to the left. Rest the chassis top on its side to avoid stressing cables.

6 At the control board, disconnect the ribbon cable that runs from J2 on the control board and the recorder. Also disconnect the ribbon cable that runs from J6 on the control board and the keypanel assembly. Make a note of where these cables connect.

7 If the SpO_2 option is present, at the SpO_2 board on the left side of the CRT, disconnect the cable from the SpO_2 board to the keypanel control board.

8 At the front end board, disconnect the black wire that runs from the top cover to the BLK LOAD RES connector on the front end board. You can now separate the chassis top and bottom.

Removing the Recorder

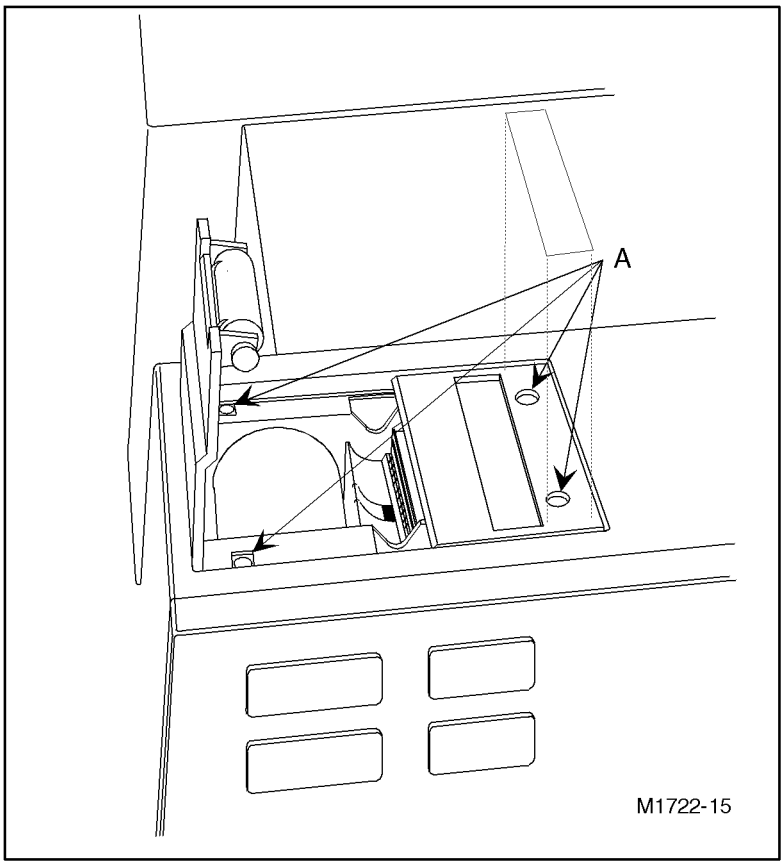
To replace any of the components on the recorder, you must first remove the recorder from the defibrillator chassis. This procedure also includes instructions for removing the recorder sliding door. The recorder can be removed without opening the defibrillator chassis. Perform the following steps.

1 At the recorder, remove and save the plastic label that covers the two screw holes. See Figure 5-3.

2 Using a Torx T-10 screwdriver, remove the four screws that secure the recorder to the chassis. Lift the recorder from the recorder bucket and disconnect the ribbon cable. Do not push down in the recorder bucket; this may cause it to drop into the chassis. Perform this procedure in reverse to install the recorder.

To remove the recorder sliding door, perform step 3.

Figure 5-3



Removing the Recorder

A. Recorder retaining screws, under open door on left and under plastic label on right

3 To remove the recorder sliding door, turn the recorder upside down, so that the sliding door is facing you and the paper roll is facing away. Note how the springs are installed on the sliding door and how the metal door limit is used to stop the travel of the sliding recorder door. (The springs are identical.)

4 Using a pair of needle-nose pliers, remove and save both springs.

5 Lift the door travel limiter up and slide the door forward, away from the recorder. Now bend the retaining clips on the door so that the door is free of the recorder. To reinstall the sliding door, perform these steps in reverse.

After removing the recorder, you can remove the recorder bucket by opening the chassis and pushing down on the recorder bucket from the top.

Removing the Recorder Platen Assembly

Perform the following procedures and steps to remove the Recorder Platen Assembly.

1 Perform the procedure “Removing the Recorder”.

2 Open the platen assembly so that the print head is visible.

3 Grasp the body of the recorder with the right hand and squeeze the body so that the hinge pins move in. When the hinge pins disengage from the platen assembly, lift the platen assembly from the hinges.

4 To install a new platen assembly, perform this procedure in reverse order.

Removing and Disassembling the Keypanel Assembly

To remove the keypanel assembly, you need to open the chassis and first remove the recorder and the recorder bucket. Perform the following procedures and steps.

1 Perform the procedure “Removing the Recorder”. This procedure includes references to opening the chassis.

2 The chassis should be open. Three clips located in the top cover secure the keypad assembly into place. Use a flat-tip screwdriver to unhook the clips and remove the keypad assembly.

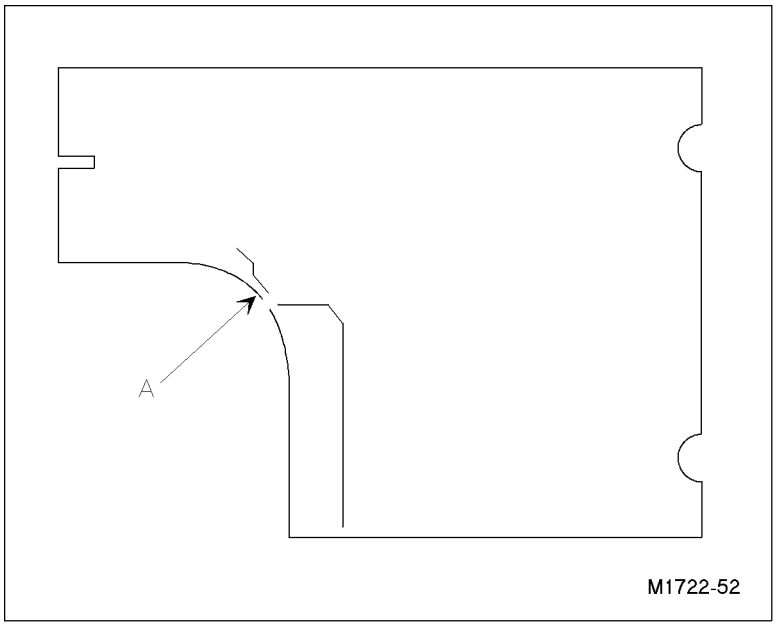
3 The keypanel circuit board, keypad, plastic lens, bezel and keylabel are all secured with two Torx T-10 screws. Remove these screws to disassemble the keypanel assembly.

4 To replace the keypanel circuit board, first disconnect the flexible circuit cable that connects the circuit board to the Energy Control knob. Use a small, flat-tip screwdriver to unhook the connector. Then separate the rubber keypad from the circuit board.

5 When installing a new keypanel circuit board, you need to configure the circuit board for use with the correct defibrillator model. If you are installing the circuit board in a model M1722A/B defibrillator/monitor (which has been manufactured prior to June, 200), leave the circuit board unchanged and install it in the unit. If you are installing the circuit board in a M1723A/B defibrillator/monitor, you will need to modify the circuit board. See Figure 5-4. On the back side of the circuit board is a small hole, with circuit etch running along the edge of the board. To configure the circuit board for use in a M1723A/B, cut the circuit etch with a pair of diagonal cutters. Then install the circuit board in the unit.

To assemble and install the keypanel assembly, perform the previous procedure in reverse order.

Figure 5-4



Configuring the Keypanel Circuit Board

A. Cut trace here to configure for a model M1722B with Option A01.

Removing the Pacer Keypad Assembly

The pacer keypad assembly consists of a small circuit board and the rubber keypad. Perform the following procedures and steps.

1 Perform the procedures “Removing the Battery” and “Opening the Defibrillator Chassis”.

2 Disconnect the cable running between the control board and the keypad assembly.

3 Remove the four screws that secure the keypad assembly. Use a T10 screwdriver.

To install the pacer keypad assembly, perform the procedure “Removing the Pacer Keypad Assembly” in reverse order.

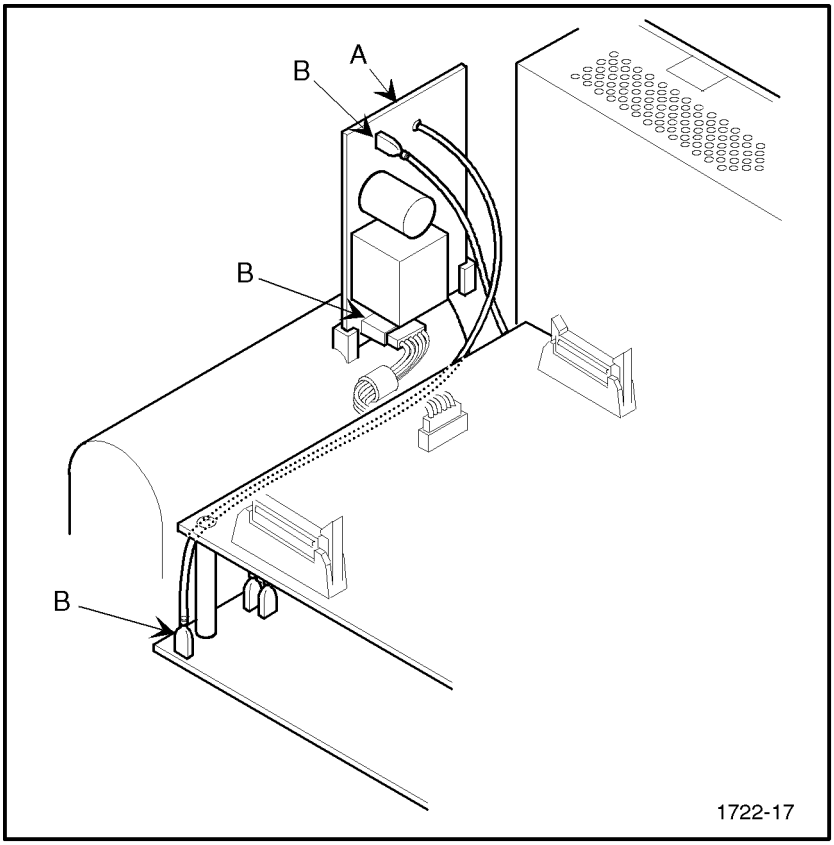
Removing the Pacer Board

The pacer function is an option to the M1722B series. Perform the following procedure to remove the pacer board.

1 Perform the procedures “Removing the Battery” and “Opening the Defibrillator Chassis”.

2 The pacer board is located to the left-rear of the chassis. This board is positioned vertically, above the high voltage capacitor. At the pacer board, disconnect the seven-pin cable assembly that runs between the pacer board and the control board (J7). See Figure 5-5.

Figure 5-5



Removing the Pacer Board

A. Pacer board
B. Disconnect these cables

3 Disconnect the red wire that runs from the patient relay (under the control board) to the jack on the pacer board. Label this wire. Plastic extrusions located on top of the high voltage capacitor case are available for stowing this wire when the pacer board is not installed.

4 Disconnect the white wire that runs from the pacer board to the WHT PACER jack on the ECG front end board.

5 The pacer board is not secured into place using screws. Gently pull the pacer board up to remove it.

To install the pacer board, perform the procedure “Removing the Pacer Board” in reverse order.

Removing the Power Supply Assembly

To remove the power supply assembly, perform the following procedures and steps.

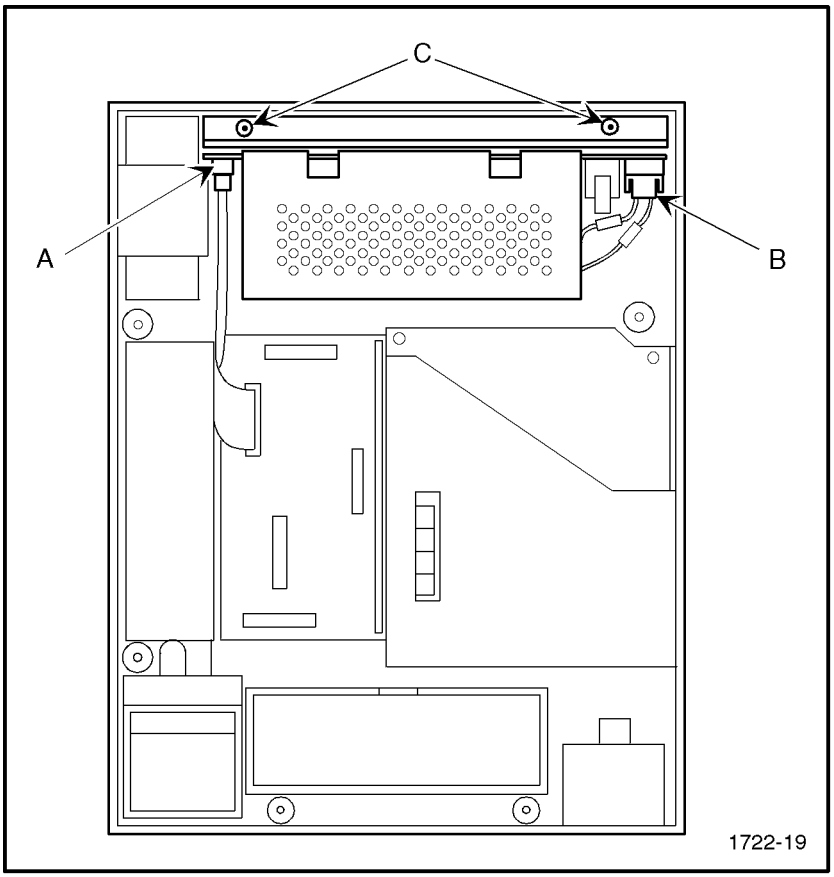
1 Perform the procedures “Removing the Battery” and “Opening the Defibrillator Chassis”.

2 The power supply assembly is positioned vertically, at the back of the chassis. Disconnect the AC input cable at the right of the power supply assembly. See Figure 5-6. (In Figure 5-6, the CRT assembly is shown removed for purposes of clarity only.)

3 At the power supply assembly, on the left, disconnect the flat ribbon cable that runs to the control board and to the high voltage charger board. Using a Torx T-15 screwdriver, remove the two screws that secure the power supply assembly to the chassis. They are located on the back side of the supply.

To install the power supply assembly, perform the procedure “Removing the Power Supply Assembly” in reverse order.

Figure 5-6



Removing the Power Supply Board

A. Ribbon cable; disconnect at power supply
B. AC input cable
C. Retaining screws, behind supply

Removing the CRT Assembly and SpO_2 Board

To remove the CRT assembly, perform the following procedures and steps.

WARNING

Be sure to wear safety glasses while performing the following step. Accidental implosion of the CRT can cause injury.

1 Perform the procedures “Removing the Battery” and “Opening the Defibrillator Chassis”.

2 Perform the procedure “Removing the Power Supply Assembly”.

WARNING

High voltages are present at the CRT anode. Use only insulated tools when performing the following step. Do not touch the metal face band of the CRT while performing the following step.

3 At the control board, disconnect the 10-conductor ribbon cable that runs between the control board and the CRT deflection board.

4 If the SpO_2 option is present, disconnect the ribbon cable from J12 on the control board. Disconnect the SpO_2 input cable from the SpO_2 board.

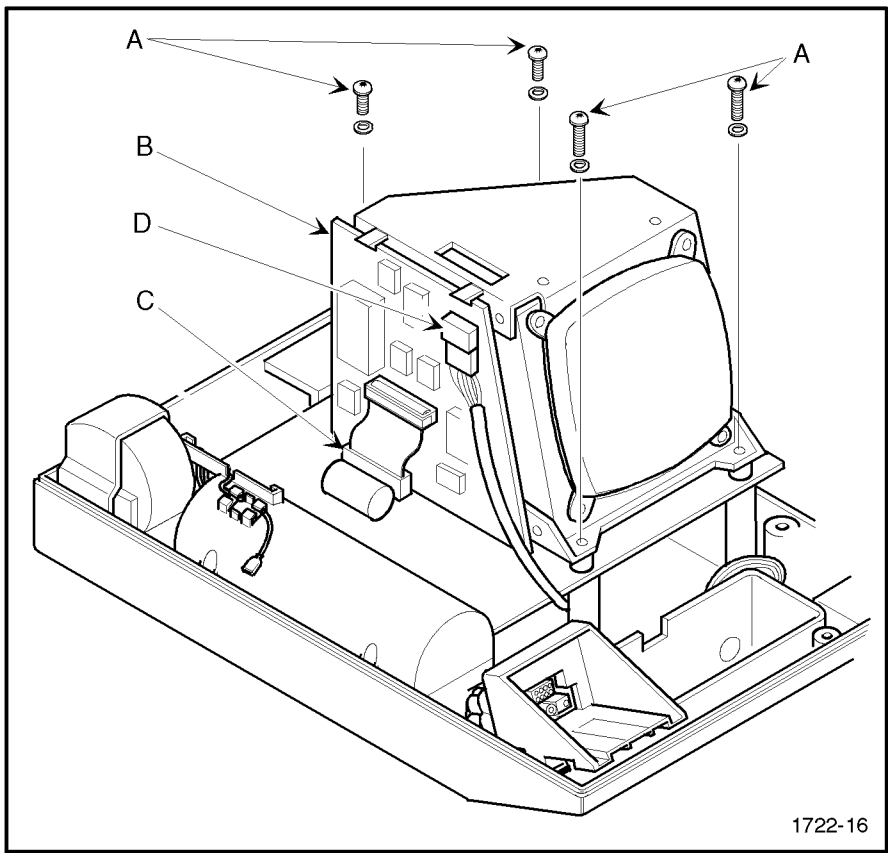
5 Using a Torx T15 screwdriver, loosen the four screws that secure the CRT assembly to the chassis. See Figure 5-7. Leave the screws in the CRT assembly, to keep them falling into the chassis. Lift the CRT assembly off the chassis and save the screws. Save the spacers beneath the CRT assembly and prevent them from falling into the chassis.

To remove the SpO_2 board:

1 Unsnap the SpO_2 board from the four tie locks near the upper and lower edges of the board.

2 If the mylar insulator beneath the board is damaged, you can remove it by cutting the tie locks off of the CRT assembly.

Figure 5-7



Removing the CRT Assembly

A. CRT assembly retaining screws

B. SpO_2 board

C. SpO_2 ribbon cable

D. SpO_2 input connector

To further disassemble the CRT assembly, perform the following steps.

1 Using insulated long-nose pliers, carefully lift the plastic collar away from the high voltage connection on the side of the CRT. Slide an insulated flat-tip screwdriver under the collar and discharge the CRT anode against the metal CRT assembly.

2 To remove the CRT itself from the assembly, remove the high voltage connection from the side of the CRT. Carefully remove the cathode connection from the end of the CRT.

3 At the deflection board, disconnect the five-wire CRT deflection connector. The CRT is now free of the assembly.

4 Remove the small connector board at the back of the CRT.

5 Using a Torx T-15 screwdriver, remove the four screws that secure the CRT to the CRT assembly. Slide the CRT forward, away from the assembly.

6 To remove the deflection board, remove the single screw that secures the deflection board to the CRT assembly. A ground wire is tied to this screw. Slide the deflection board from the yoke assembly out from the CRT assembly.

To replace the SpO_2 mylar insulator, position a new sheet over the holes in the CRT assembly. Using a $\frac{3}{16}$" nut driver, snap new tie locks into the CRT holes. Line up the holes on the SpO_2 board with the tie locks, and snap the SpO_2 board into the tie locks without flexing the board.

To install the deflection board, the CRT and the CRT assembly, perform the above procedure in reverse order.

Removing the Control Board

To remove the control board, perform the following procedures and steps.

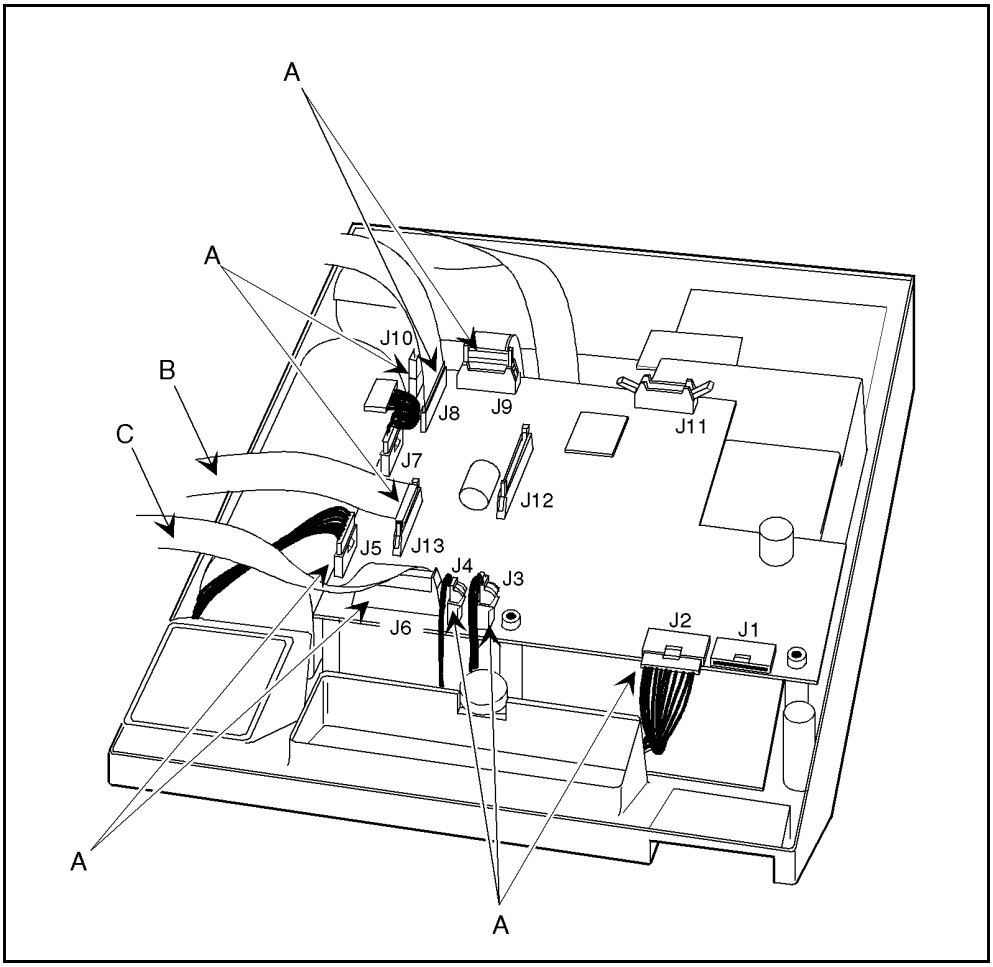
1 Perform the procedure “Removing the Pacer Board”.

2 Perform the procedure “Removing the Power Supply Assembly”.

3 Perform the procedure “Removing the CRT Assembly and SpO_2 Board”.

4 At the control board, disconnect all remaining cables. Connectors are J1 through J13. Save the loose cable that connects to J11. J12 connects to the SpO_2 option cable. Figure 5-8 shows the locations of the cables and connectors.

Figure 5-8



Removing the Control Board Cables and Connectors

A. Cables and connectors to remove
B. This cable connects to the recorder
C. This cable connects to the keypanel assembly

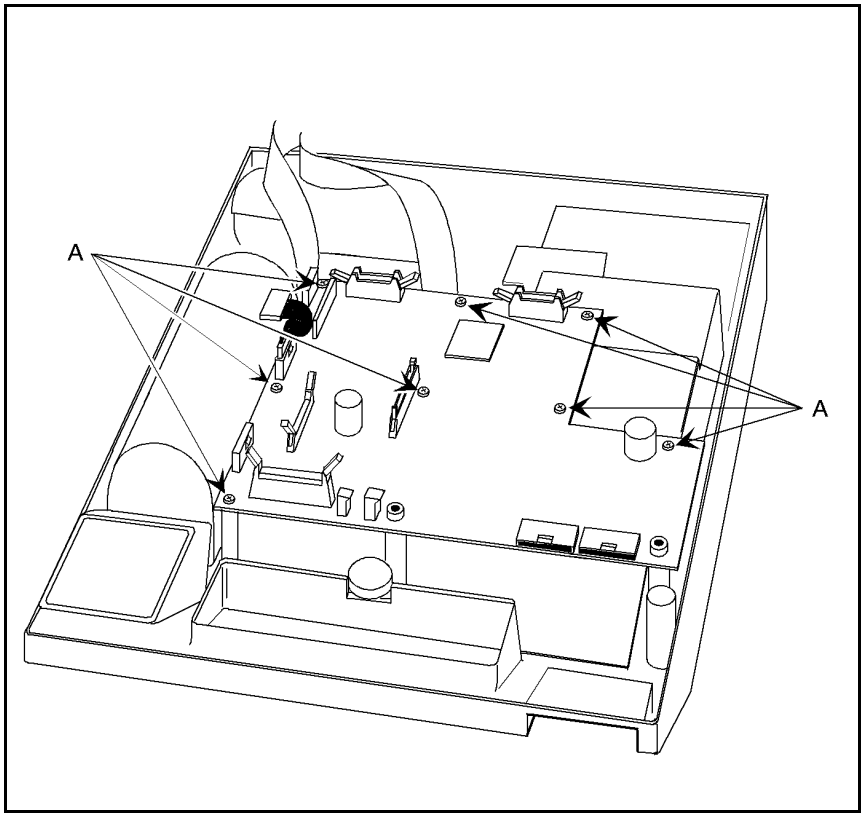
CAUTION

To avoid shorting the lithium battery, do not place the control board on a conductive surface.

5 Using the Torx T-10 screwdriver, remove the screws that secure the control board to the chassis. Figure 5-9 shows the locations of the retaining screws. Remove the control board from the chassis and place it on a non-conductive surface. This will avoid shorting the terminals on the lithium battery.

To install the control board, perform the procedure “Removing the Control Board” in reverse order. Calibrate the peak current measurement circuitry using the procedure “Adjusting the Internal Delivered Energy Calibration” on page 5-30.

Figure 5-9



Removing the Control Board

A. Control board retaining screws

Removing the ECG Front End Board

To remove the ECG front end board, perform the following procedures and steps.

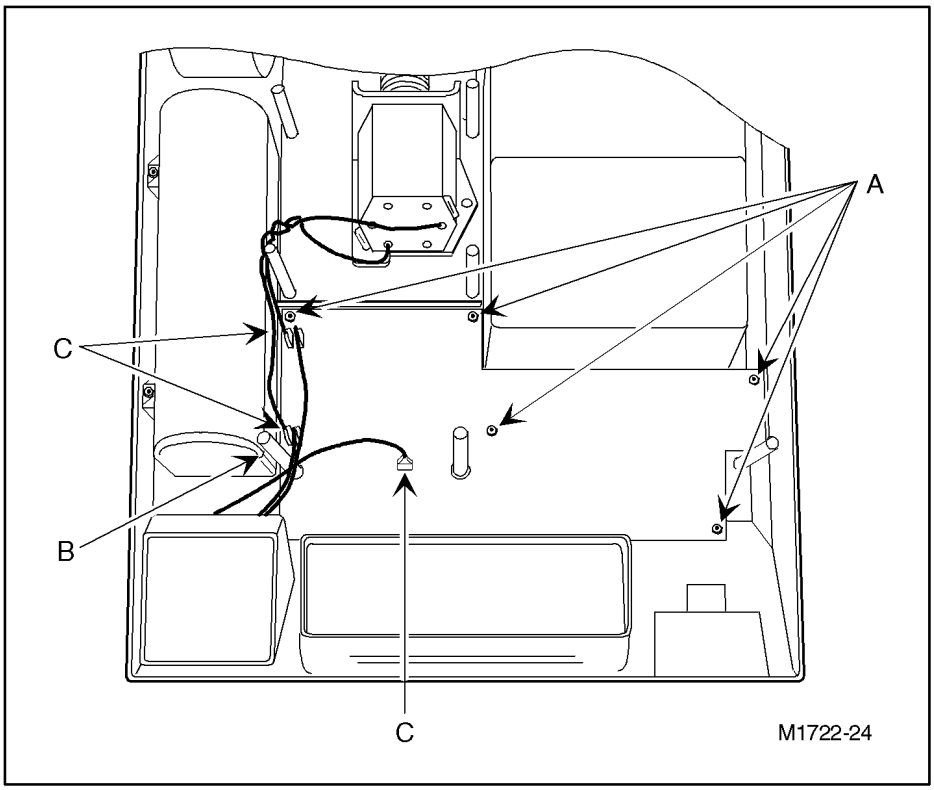
1 Perform the procedures “Removing the Battery” and “Opening the Defibrillator Chassis”.

2 Perform the procedure “Removing the Control Board”. This procedure instructs you to access the chassis and also remove the pacer board, power supply, CRT assembly and control board.

3 At the ECG front end board, two red wires attach to the RED STERNUM connector. One wire runs to the patient cables connector. The other wire runs to the patient relay. Disconnect both wires. See Figure 5-10.

4 At the front end board, two white wires attach to the WHT APEX connector. One wire runs to the patient cables connector. The other wire runs to the patient relay. Disconnect both wires.

Figure 5-10



Removing the ECG Front End Board

A. Retaining screws
B. Plastic standoff
C. Cables and connectors

5 Disconnect the 7-conductor cable assembly that runs between the ECG input connector and the flat 7-pin connector on the front end board.

6 Using a Torx T-10 screwdriver, remove the QRS beeper volume control potentiometer. This is located on the front of the chassis. Squeeze the plastic ears to remove the ECG input connector from the front of the instrument. The connector and cable will pull out to the front of the machine.

7 Using a pair of pliers, remove the ECG output connector. This is located on the front of the chassis.

8 Using a 5/16" nut driver, remove the plastic standoff that supports the control board.

9 Using a Torx T-10 screwdriver, remove the five screws that secure the front end board to the chassis. You can now remove the front end board.
To install the front end board, perform the procedure “Removing the ECG Front End Board” in reverse. Make sure that the correct wires are connected to the proper connector. Check wire colors using Figure 5-13 and Figure 5-14.

Removing the High Voltage Charger and Relay Assembly

This procedure includes removing the patient relay and the high voltage charger board. The high voltage charger and relay assembly consists of the high voltage charger board, the patient relay, high voltage capacitor and patient inductor. This assembly is located under the control board, at the left-rear corner of the instrument. Perform the following procedures and steps to remove the assembly.

WARNING

The high voltage storage capacitor can store lethal amounts of energy. Be sure that this capacitor is discharged before touching high voltage components, such as the high voltage capacitor, patient inductor, patient relay, or patient cable connector. To discharge the high voltage capacitor:

1 Be sure to wear safety glasses while discharging the capacitor.

2 In diagnostic mode make sure that the Available Energy is 0 (the Energy Select control is in the Monitor--On position).

3 Turn the Energy Select control to Off (Standby).

4 Wait 30 seconds before opening the unit.

5 In case of a defective safety relay, if you do not short the high voltage capacitor, you may have to wait one hour to service the unit.

1 Perform the procedures “Removing the Battery” and “Opening the Defibrillator Chassis”.

2 Perform the procedure “Removing the Power Supply Assembly”.

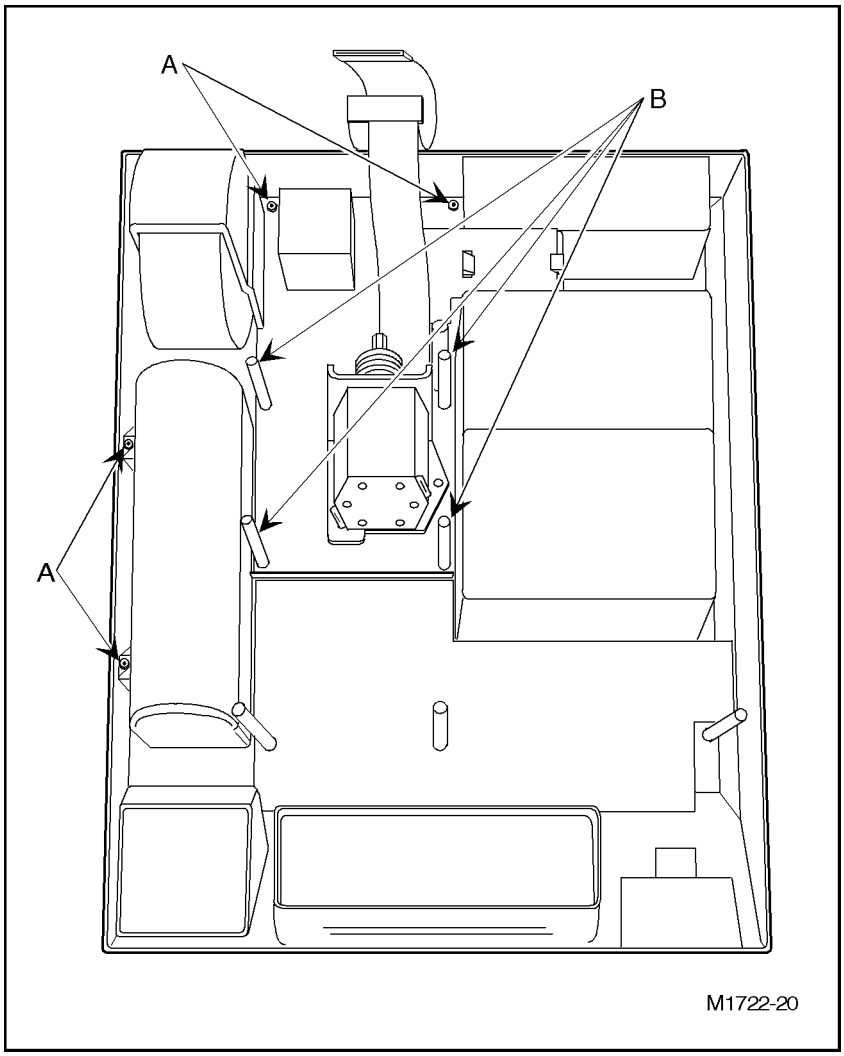
3 Perform the procedure “Removing the Control Board”. This procedure instructs you to open the chassis and also remove the CRT assembly and the pacer board.

4 The battery connector board is positioned beneath the power supply and is attached to the high voltage charger assembly with soldered wires. To remove the battery connector board, first remove the black rubber plug and then release the latch that secures the board in place. See Figure 5-11. When reinstalling the battery connector board, be sure that the alignment pin on the chassis bottom is centered in the hole on the board.

5 Using the Torx T-10 screwdriver, remove screws that fasten the high voltage charger and relay assembly to the chassis. See Figure 5-11. Two screws are located on the high voltage charger board and two screws are located on the high voltage capacitor case.

6 Disconnect the patient relay wires that connect the front end board. Be certain to label each wire.

Figure 5-11



Removing the High Voltage Charger and Relay Assembly

A. Retaining screws
B. Standoffs

7 Four vertical standoffs are fastened to the high voltage charger board and are used to support the control board. Using a 5/16: nut driver, remove these standoffs.

8 You can now remove the high voltage charger and relay assembly from the chassis.

9 To remove the patient relay, disconnect each of the wires leading from the patient relay to the assembly. Be certain to label each wire. Using a Torx T-10 screwdriver, remove the single screw.

10 To remove the high voltage charger board, disconnect the three wires (two red and one white) from the high voltage capacitor and the patient inductor. Label these wires so that you can reinstall components correctly.

To install the high voltage charger board, perform the procedure “Removing the High Voltage Charger and Relay Assembly” in reverse. Refer to the Interconnect Block Diagram (Figure A-1) in Appendix A for wiring information. Refer to Figure 5-13 and Figure 5-14 for wire connections.

Removing the High Voltage Capacitor

To remove the high voltage capacitor, perform the following procedures and steps.

WARNING

The high voltage storage capacitor can store lethal amounts of energy. Be sure that this capacitor is discharged before touching high voltage components, such as the high voltage capacitor, patient inductor, patient relay, or patient cable connector. To discharge the high voltage capacitor:

1 Be sure to wear safety glasses while discharging the capacitor.

2 In diagnostic mode make sure that the Available Energy is 0 (the Energy Select control is in the Monitor--On position).

3 Turn the Energy Select control to Off (Standby).

4 Wait 30 seconds before opening the unit.

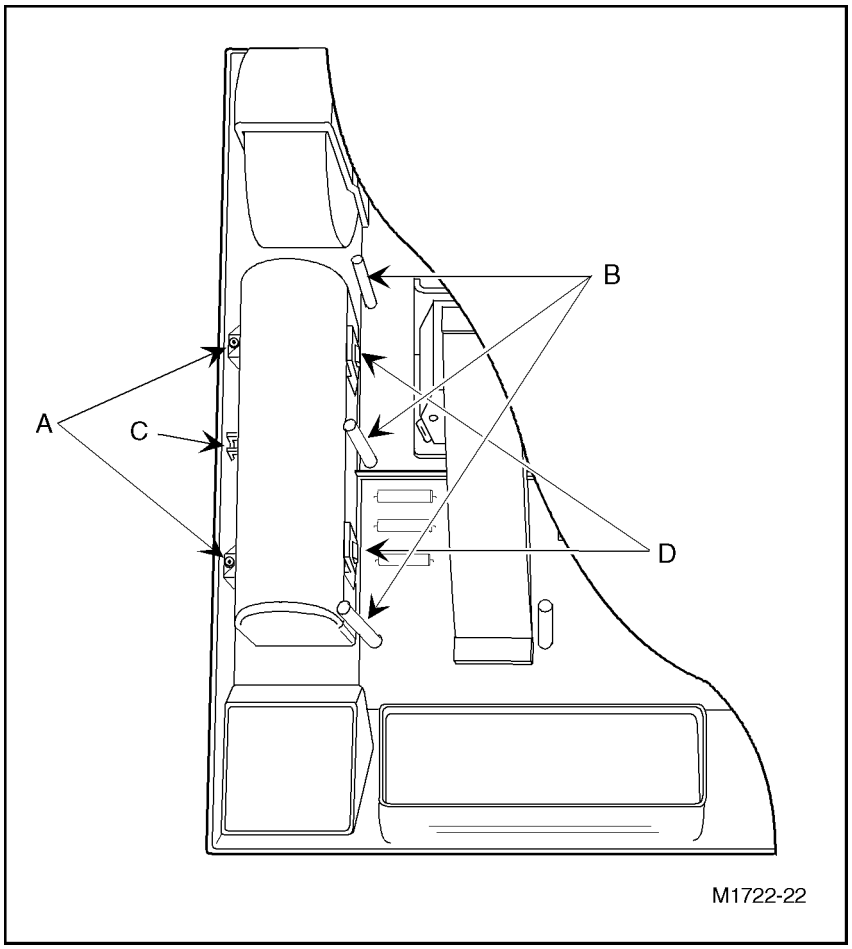
5 In case of a defective safety relay, if you do not short the high voltage capacitor, you may have to wait one hour to service the unit.

1 Perform the procedures “Removing the Battery” and “Opening the Defibrillator Chassis”.

2 Perform the procedure “Removing the Control Board”. This procedure instructs you to access the chassis and also remove the CRT assembly and the pacer board.

3 The front of the defibrillator chassis should be facing you, with the high voltage capacitor to the left, as shown in Figure 5-12. Using a 5/16" nut driver, remove the three vertical standoffs positioned next to the high voltage capacitor.

Figure 5-12



Removing the High Voltage Capacitor

A. Retaining screws
B. Standoffs, remove
C. Release clip, open to the right
D. Hinge clips

4 Remove the two retaining screws that secure the capacitor cover, on the left.

5 Insert a flat-tip screwdriver under the plastic latch on the left side of the capacitor and unhook the latch. Open the plastic high voltage capacitor cover to the right and unhook the two plastic latches on the right of the cover.

6 Disconnect the two wires (one red and one white) from the high voltage charger board. On the charger board, these jacks are labeled HV RED and HV WHITE.

WARNING

Do not remove the resistor from the capacitor terminals.

To install the high voltage capacitor, perform the procedure “Removing the High Voltage Capacitor” in reverse. Refer to Figure 5-13 and Figure 5-14 for wire connections.

WARNING

The high voltage capacitor can store lethal amounts of energy. When accessing the high voltage capacitor, be sure to follow the instructions and observe the warning under “Removing the High Voltage Capacitor”.

Removing the Patient Inductor

WARNING

The high voltage storage capacitor can store lethal amounts of energy. Be sure that this capacitor is discharged before touching high voltage components, such as the high voltage capacitor, patient inductor, patient relay, or patient cable connector. To discharge the high voltage capacitor:

1. **Be sure to wear safety glasses while discharging the capacitor.**
2. **In diagnostic mode make sure that the Available Energy is 0 (the Energy Select control is in the Monitor--On position).**
3. **Turn the Energy Select control to Off (Standby).**
4. **Wait 30 seconds before opening the unit.**
5. **After accessing the chassis as described in step 1 below, short the terminals of the high voltage capacitor.**

You can use a screwdriver with an insulated handle to short the capacitor terminals.

To remove the patient inductor, perform the following procedures and steps.

1. Perform the procedures “Removing the Battery” and “Opening the Defibrillator Chassis”.
2. Perform the procedure “Removing the Control Board”. This procedure instructs you to access the chassis and also remove the pacer board, power supply, and CRT assembly.

3 At the patient inductor, disconnect and label the red wire that runs to the patient relay and the red wire that runs to the high voltage charger board.

4 Using a flat-tip screwdriver, remove the plastic retaining clip that secures the inductor to the chassis. Remove the inductor.

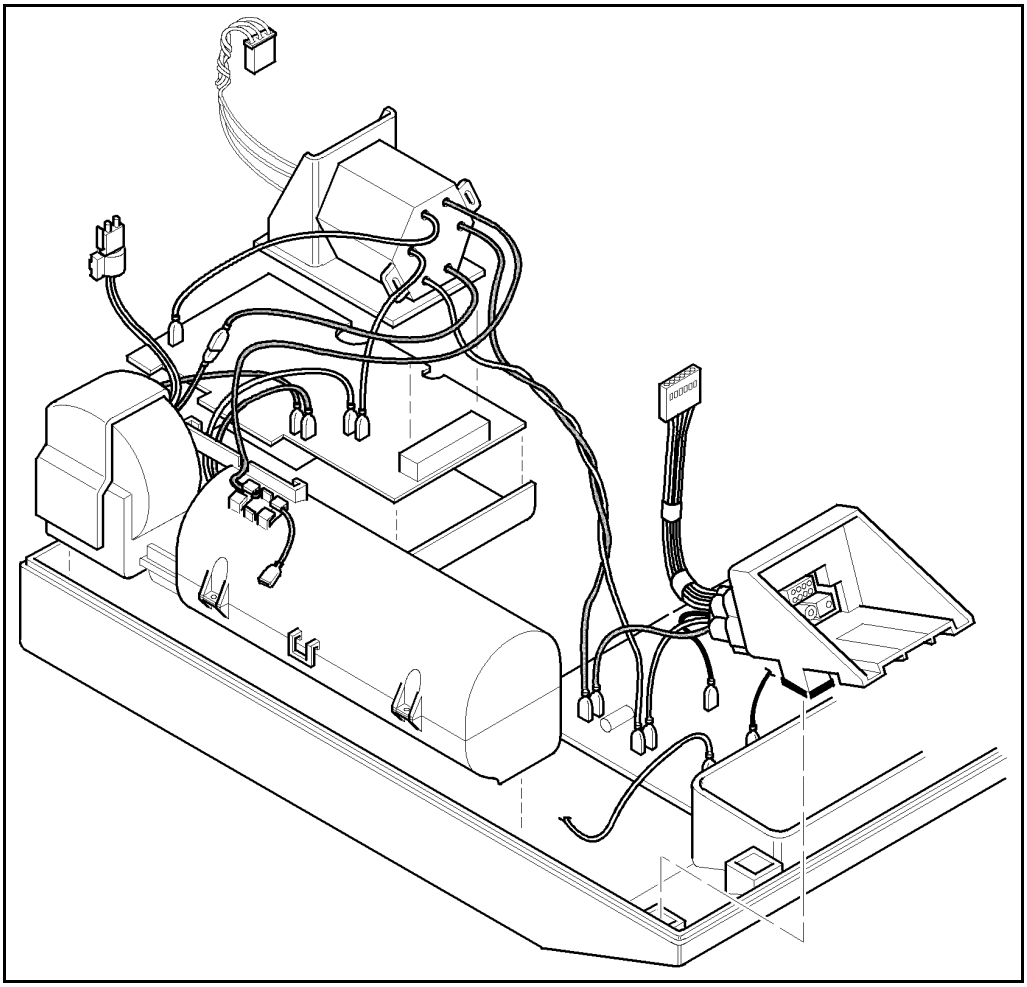
To install the patient inductor, perform the following steps.

1 Insert the patient inductor so that the wires face toward the center of the chassis. Install the plastic retaining clip to secure the inductor.

2 Connect the shortest red wire from the inductor to the shortest red wire on the patient relay. Connect the longer red wire from the inductor to the HV RED jack on the high voltage charger board.

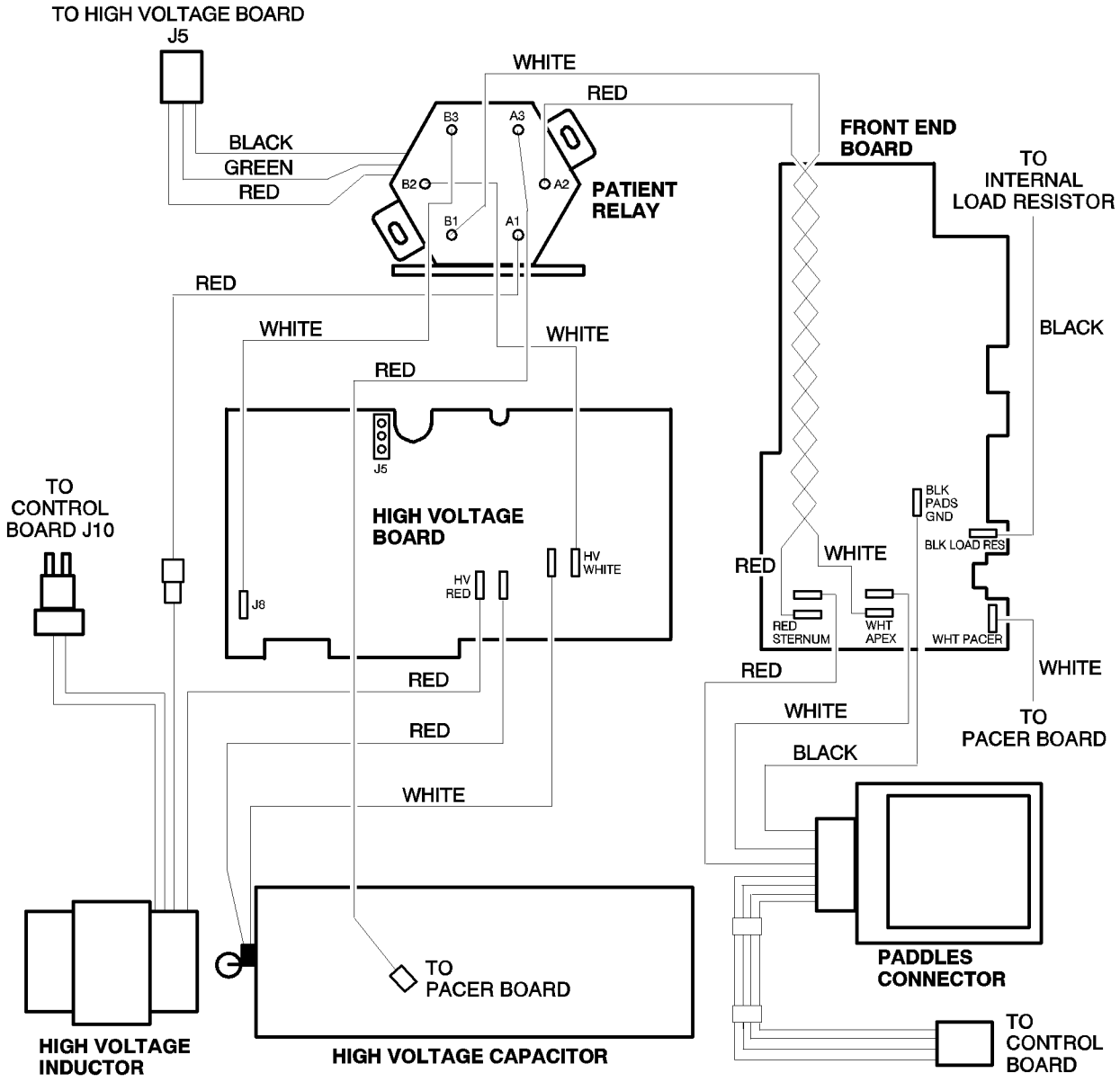
3 Perform the procedure “Removing the Patient Inductor”, steps 3 through 1, in reverse order. Refer to Figure 5-13 and Figure 5-14 for wire connections. Calibrate the peak current circuitry using the procedure “Adjusting the Internal Delivered Energy Calibration” described later in this chapter.

Figure 5-13



High Voltage Connection Diagram (front view)

Figure 5-14



High Voltage Connection Diagram (schematic)

Adjusting the CRT

There are five CRT adjustments that can be performed. These adjust the intensity, vertical size, vertical position, horizontal focus and rotational position of the display. Perform the following steps to adjust the CRT.

1 Perform the procedures “Removing the Battery” and “Opening the Defibrillator Chassis”. However, leave all front panel cables connected except for the optional pacer keyboard cable.

WARNING

Dangerous voltages are exposed when performing this procedure. Be certain not to touch the circuitry, wiring, or components while performing this procedure. This procedure is to be performed only by qualified service personnel.

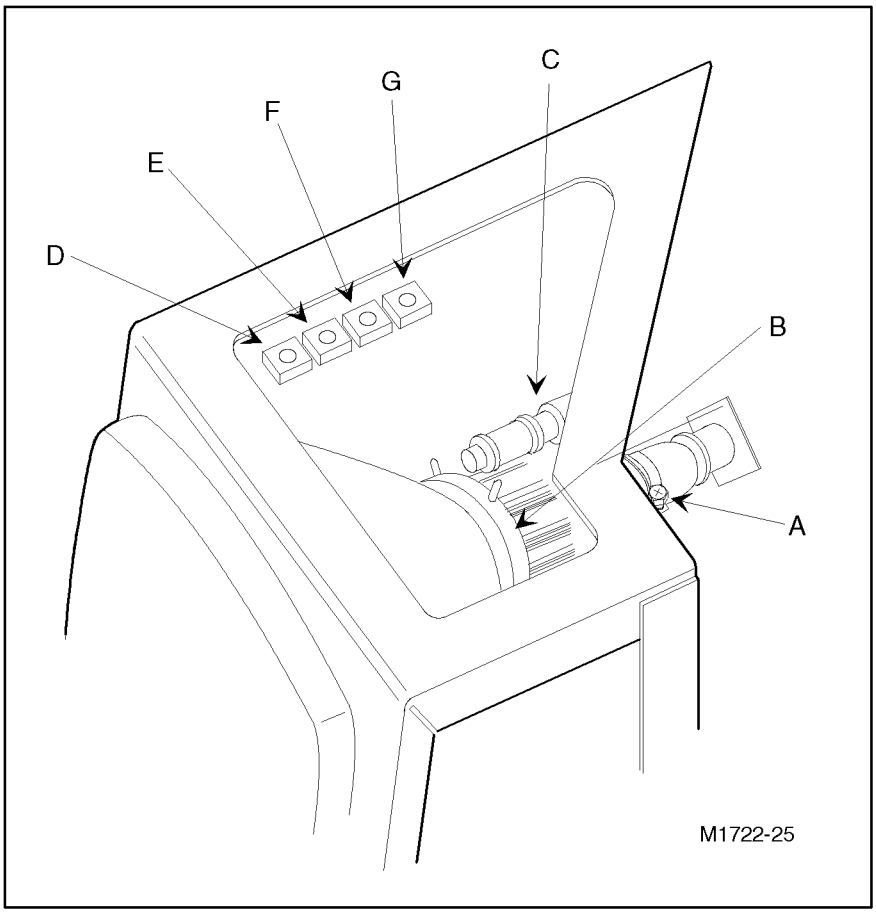
2 Be certain that AC power is removed from the defibrillator. Lift the base of the chassis up and reinstall the battery. Install and secure the battery door.

3 While pressing the (Sync) and (HR Alarm) keys, turn the Energy Select switch to **Monitor On**.

4 Press the (ECG Size) key to select TEST CRT on the screen. Then press the (Lead Select) key. The CRT test display is shown on the screen.

5 To adjust the horizontal rotation of the display, you will adjust the position of the yoke. Loosen the machine screw on the yoke clamp. Use an insulated 7/32 allen wrench. See Figure 5-15.

Figure 5-15



CRT Adjustments

A.Yoke clamp and screw
B.Yoke
C.Horizontal size adjustment
D.Vertical position adjustment
E.Vertical size adjustment
F.Focus adjustment
G.Intensity adjustment

6 Using a non-conductive probe, rotate the CRT yoke in either direction while viewing the display. Position the yoke so that the display is positioned in the most vertical/horizontal position. Tighten the yoke clamp when the display is satisfactory.

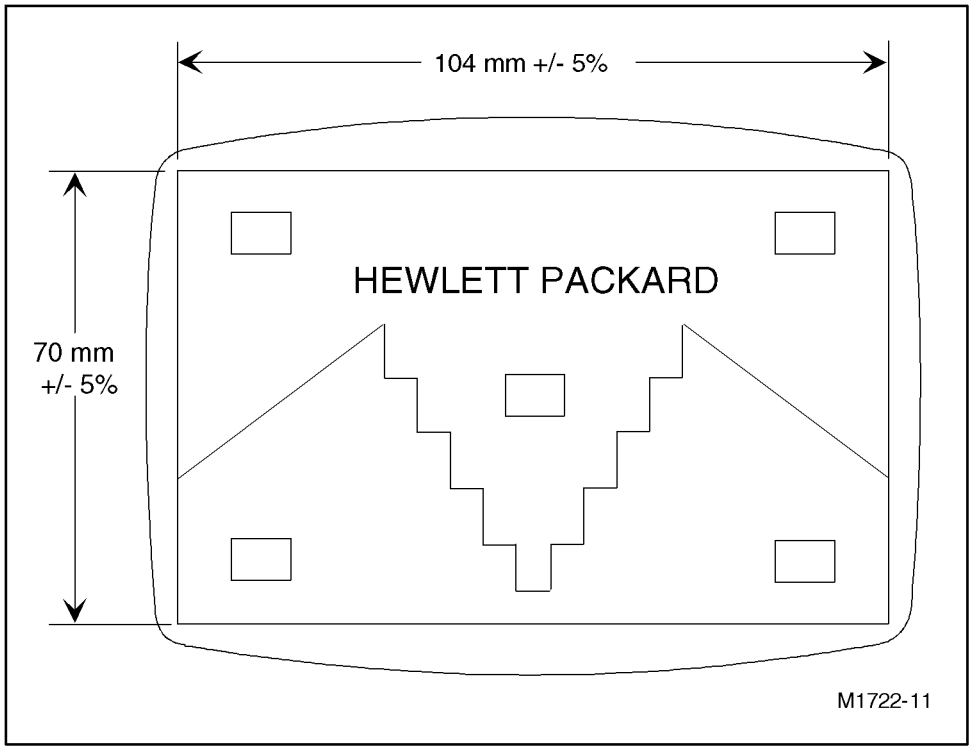
7 To adjust the horizontal size, or gain of the display, insert a 3/32" plastic Allen wrench (part number 8710-1355) into the back of the small inductor, located on the CRT yoke. Rotate the inductor core to adjust the horizontal size of the display so that it matches the dimensions shown in Figure 5-16.

8 To adjust horizontal centering, you must adjust magnets on the back of the yoke assembly. Place the magnets at 3:00 and 9:00 positions. Move the two magnets up (towards 12:00) together or down (towards 6:00) to shift the display image.

9 To adjust the vertical position of the display, adjust the front-most potentiometer, located on the top of the CRT deflection circuit board. Use an insulated flat-tip screwdriver.

10 To adjust the vertical size, or gain of the display, adjust the second potentiometer in line, on the top of the CRT deflection board. Set the vertical size to the dimensions shown in Figure 5-16. Use an insulated flat-tip screwdriver.

Figure 5-16



CRT Test Pattern

11 To adjust the display focus, adjust the third potentiometer in line, on the top of the CRT deflection board. Use an insulated flat-tip screwdriver.

12 To adjust the display intensity, adjust the last potentiometer in line, on the top of the CRT deflection board. Use an insulated flat-tip screwdriver.

13 Turn the Energy Select switch to **Off (Standby)**.

14 Remove the battery from the bottom of the defibrillator.

15 Reconnect the pacer cable assembly (if present) at the right-most connector on the control board.

16 Close the defibrillator chassis and install the six screws. This completes the CRT Adjustments procedure.

Adjusting the Internal Delivered Energy Calibration

On revision B and later control boards you can calibrate the Peak Current measurement circuitry in the M1722/M1723 family of defibrillator/monitors.

Perform this calibration only when replacing a control board, or Patient Inductor in the defibrillator, or when a user suspects that the reported delivered energy is incorrect.

Equipment required:

Calibrated defibrillator test box. (50 Ohm load ±1%, Measurement of delivered energy ±2%).

Insulated adjustment tool.

To calibrate the internal delivered energy measurement, perform the following steps:

1 Calibrate the defibrillator capacitor by selecting the CALIBRATE DEFIB calibration procedure in the diagnostic service mode of the instrument. Follow the instructions on the screen.

2 Charge the defibrillator to 100 Joules and discharge into the test box. Verify that the defibrillator delivered between 90 and 110 joules of energy into the test box.

Do not proceed if the defibrillator delivered less than 90 Joules or greater than 110 Joules; instead refer to Chapter 4, **Troubleshooting**, for detailed troubleshooting information.

3 If AC power is connected, remove it now.

4 Perform the procedures “Removing the Battery” and “Opening the Defibrillator Chassis”. However, leave all front panel cables connected except for the optional pacer keyboard cable.

WARNING

Dangerous voltages are exposed when performing this procedure. Be certain not to touch the circuitry, wiring, or components while performing this procedure. This procedure is to be performed only by qualified service personnel.

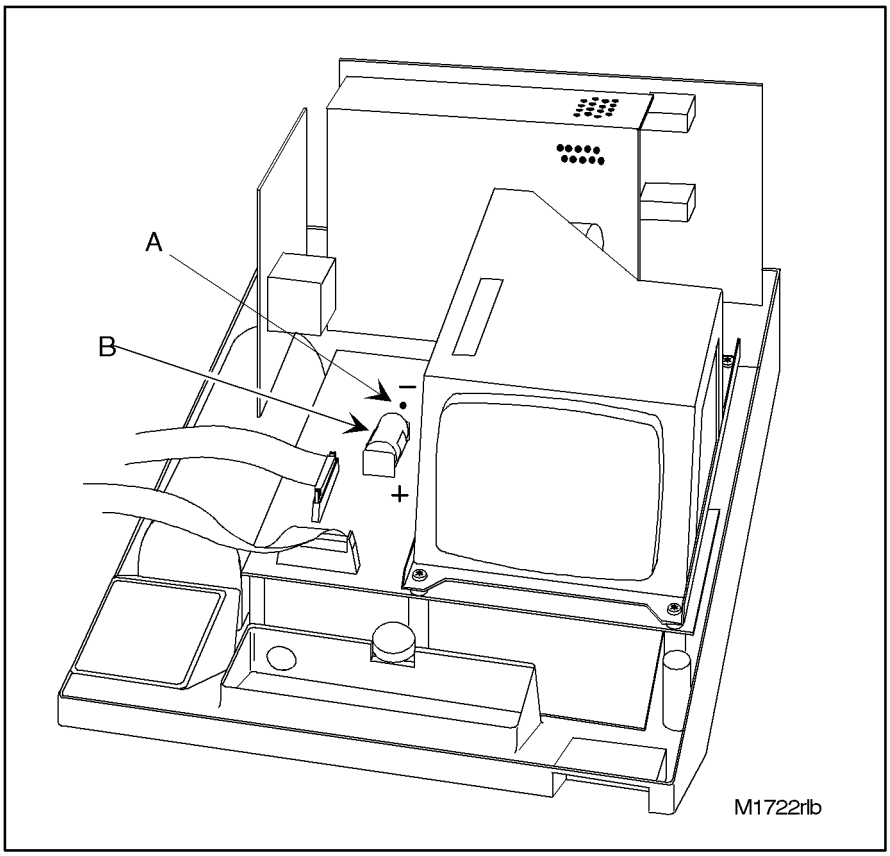
5 Lift the base of the chassis up and reinstall the battery. Install and secure the battery door.

6 While pressing the (Sync) and (HR Alarm) keys, turn the Energy Select switch to **Monitor On**.

7 Press the (ECG Size) key to select TEST DEFIB on the screen. Then press the (Lead Select) key. The TEST DEFIB screen should now be displayed on the CRT.

8 Locate the potentiometer R139 as shown in Figure 5-17.

Figure 5-17



R139 Potentiometer

A.R139 Potentiometer
B.Lithium battery

9 Attach the paddle set to the defibrillator connector.

10 Charge the defibrillator to 100 joules and discharge into the defibrillator test box.

11 Read the impedance measurement on the TEST DEFIB screen.

Example section of TEST DEFIB screen:

DELIVERED ENERGY:	**100**
IMPEDANCE:	**50**
PEAK CURRENT:	**29**

Adjust R139 clockwise if the displayed impedance is greater than 50 Ohms, counter-clockwise if the displayed impedance is less than 50 Ohms. Repeat from step 10 until the impedance measurement reads 50 Ohms.

12 Turn the Energy Select switch to **Off (Standby)**.

13 Remove the battery from the bottom of the defibrillator.

14 Reconnect the pacer keypanel cable assembly (if present) at the right-most connector on the control board.

15 Close the defibrillator chassis and install the six case screws. Reinstall the battery.

16 Turn the Energy Select switch to the 100 Joule position, and perform a 100 Joule delivered energy test (Paddles in pockets). Verify that the recorder prints TEST 100J PASSED. This completes the Internal Delivered Energy Measurement adjustment procedure.

Replacing the Lithium Battery

The lithium battery is located on the control board. This battery provides voltage to memory which stores setting information. To replace the battery, perform the following procedures and steps.

WARNING

Observe all lithium battery warnings. There is a risk of fire, explosion, or burns. Do not recharge, disassemble, heat above 100° C (212° F), incinerate, or solder directly on the cell. Do not short circuit the battery.

1 If the current parameter settings are still valid, print them out. You can use the print-out to restore the correct settings after replacing the battery. See “Displaying/Printing Configuration Settings” on page 2-19 for instructions on printing the current settings.

2 Perform the procedures “Removing the Battery” and “Opening the Defibrillator Chassis”.

3 The lithium battery is located on the control board, left of the CRT, as shown in Figure 5-18. Using an insulated probe, remove the battery. Replace the lithium battery only with an approved HP battery (part number 1420-0341), or damage to the instrument may result. Note the polarity marking shown in the figure.

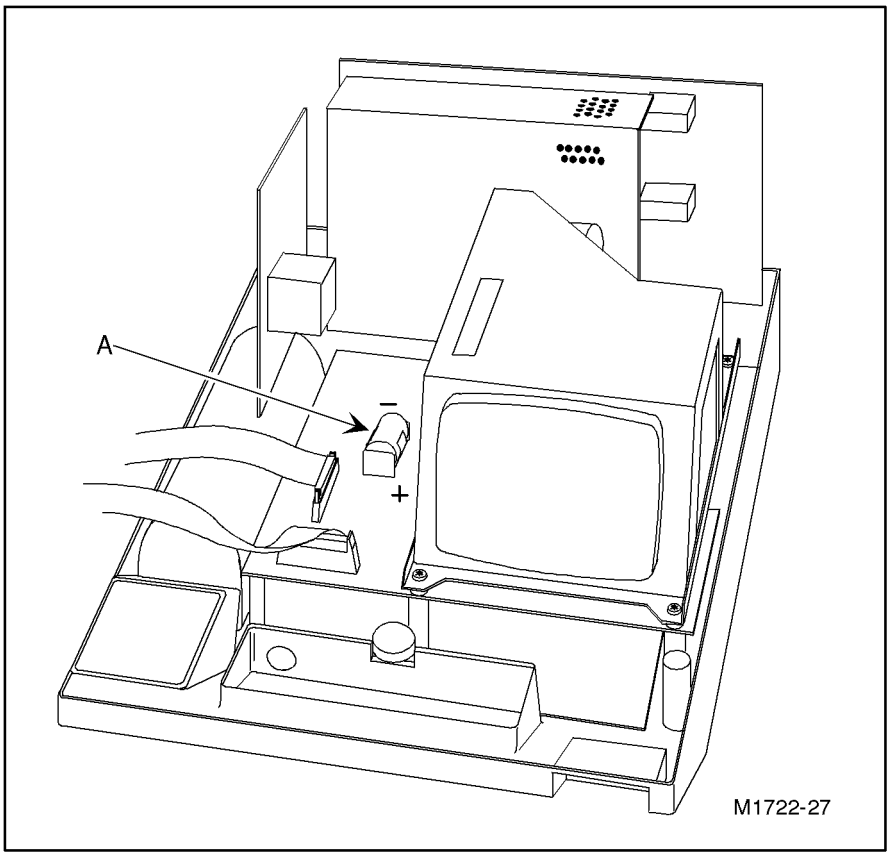
4 Reconnect any cables that were disconnected to perform this procedure.

5 Close the chassis cover. Install the six screws that secure the chassis.

6 Reinstall the lead-acid battery (on the bottom of the instrument) and battery cover.

7 When you turn on the defibrillator, it displays a message indicating that system settings have been lost. See“Changing Configuration Settings” on page 2-22 for instructions on restoring system settings. Use the printout of system settings obtained in step 1 of this procedure.

Figure 5-18



Replacing the Lithium Battery

A.Lithium battery

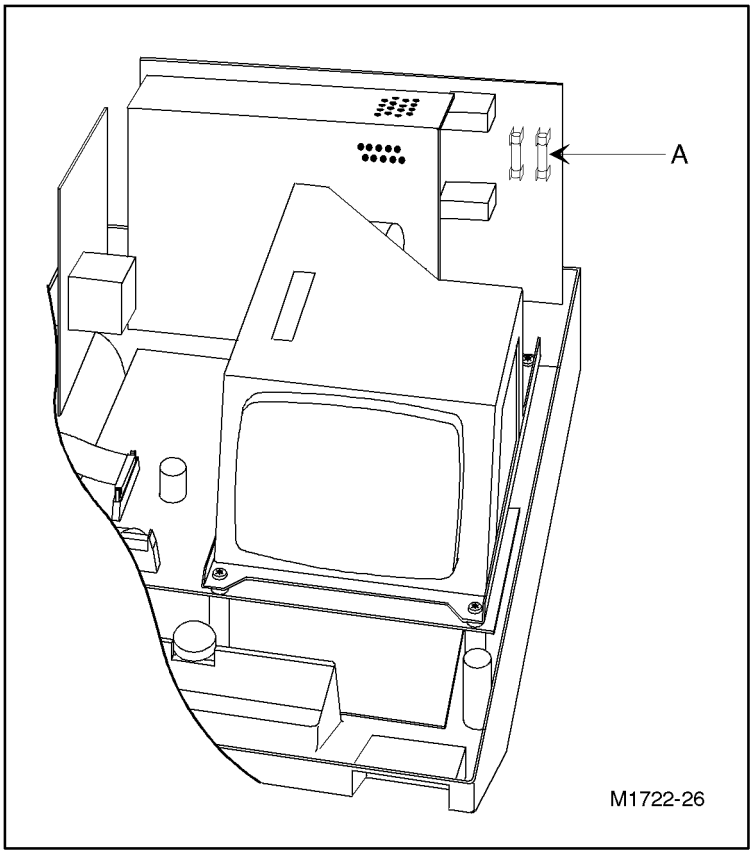
Replacing the Power Supply Fuses

There are two power supply fuses located on the power supply. To replace either fuse, perform the following procedures and steps.

1 Perform the procedures “Removing the Battery” and “Opening the Defibrillator Chassis”.

2 The power supply fuses are located as shown in Figure 5-19. Replace both fuses only with 250 volt, 4.0 ampere rate fuses (part number 2110-0055)

Figure 5-19



Replacing the Power Supply Fuses

A.Power supply fuses

3 Reconnect all cables removed and install the chassis top cover.

4 Install the six screws that secure the chassis.

5 Reinstall the lower battery and battery cover.

Replacing the Battery Fuse

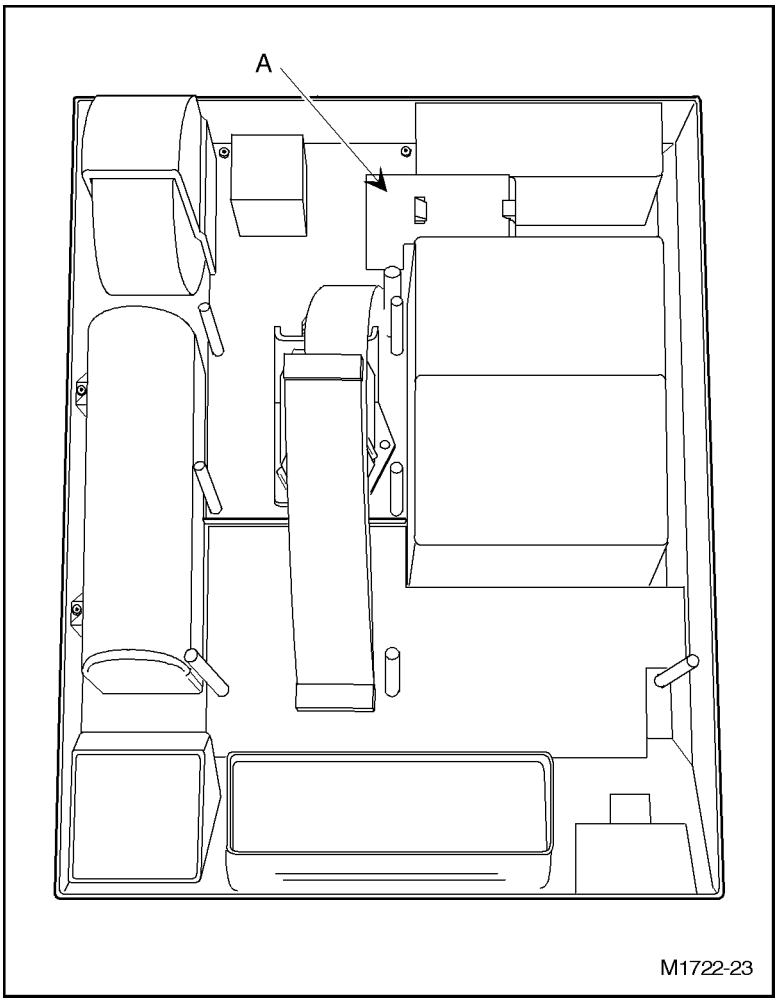
The battery fuse is located on the battery connector board, beneath the power supply and just above the high voltage charger board. To change the battery fuse, perform the following procedures and steps.

1 Perform the procedures “Removing the Battery” and “Opening the Defibrillator Chassis”.

2 Perform the procedure “Removing the Power Supply Assembly”.

3 The battery connector board is located behind the CRT and is held in place by a rubber plug and two plastic clips. Remove the rubber plug and then, pressing the retaining clip forward, lift the board out. See Figure 5-20.

Figure 5-20



Replacing the Battery Fuse

A.Battery connector board, with CRT assembly removed.

4 Replace the battery fuse only with a 32 volt, 25 ampere fuse (part number 2110- 0250)

5 Reinstall the battery connector board and the rubber plug. Be sure that board is held securely in place.

6 Reinstall the power supply assembly.

7 Reinstall all cables removed and install the chassis top cover.

8 Install the six screws that secure the chassis.

9 Reinstall the lower battery and battery cover.

Verifying Operation After Service

See Chapter 3, **Performance Verification and Maintenance**, to verify operation after service.

Parts Lists

Introduction

This chapter contains parts lists for these assemblies:

• defibrillator main assembly

• battery door

• key panel assembly

• high voltage assembly

• CRT assembly

• recorder

• external paddle sets

In addition, Table 6-11 lists ordering information for supplies.

The CodeMaster Models

The CodeMaster defibrillator/monitor is available in one model:

• Model M1722B XL+

The previous models M1722A and M1723A/B, have been consolidated under one master model number M1722B.

NOTE

CodeMaster XL+ is available in white or yellow colored enclosure. The model with the option #048 (previously suffix A) is white and option #049 (previously suffix B) is yellow. Consequently, some parts in the parts list are available in both colors -- primary case parts and labels. Parts in white and yellow have different part numbers.

Ordering Information

You may order any of the parts listed through your local Sales/Service Office (listed at the back of this manual). In the United States and Canada, you can call the Direct Customer Order Center (toll-free) 1-800-227-8164.

In the United States, you can order supplies for the defibrillator by calling (toll-free) 1-800-225-0230. You can order HP 1290C transducers by calling (toll-free) 1-800-934-7372. You can order instrument repair parts by calling (toll-free) 1-800-227-8164.

Outside the United States, you can order supplies for the defibrillator by contacting your HP regional medical distributor.

Calling for Assistance

You can call Service for technical assistance.

United States of America

Medical Response Center **Tel: 1-800-548-8833**

Canada

Eastern Region	**Tel: 1-800-361-9790**
Central and Western Region	**Tel: 1-800-268- 1221**

Other International Areas

Australia	**France**
Tel: 131147	**Tel: 0803 35 34 33**

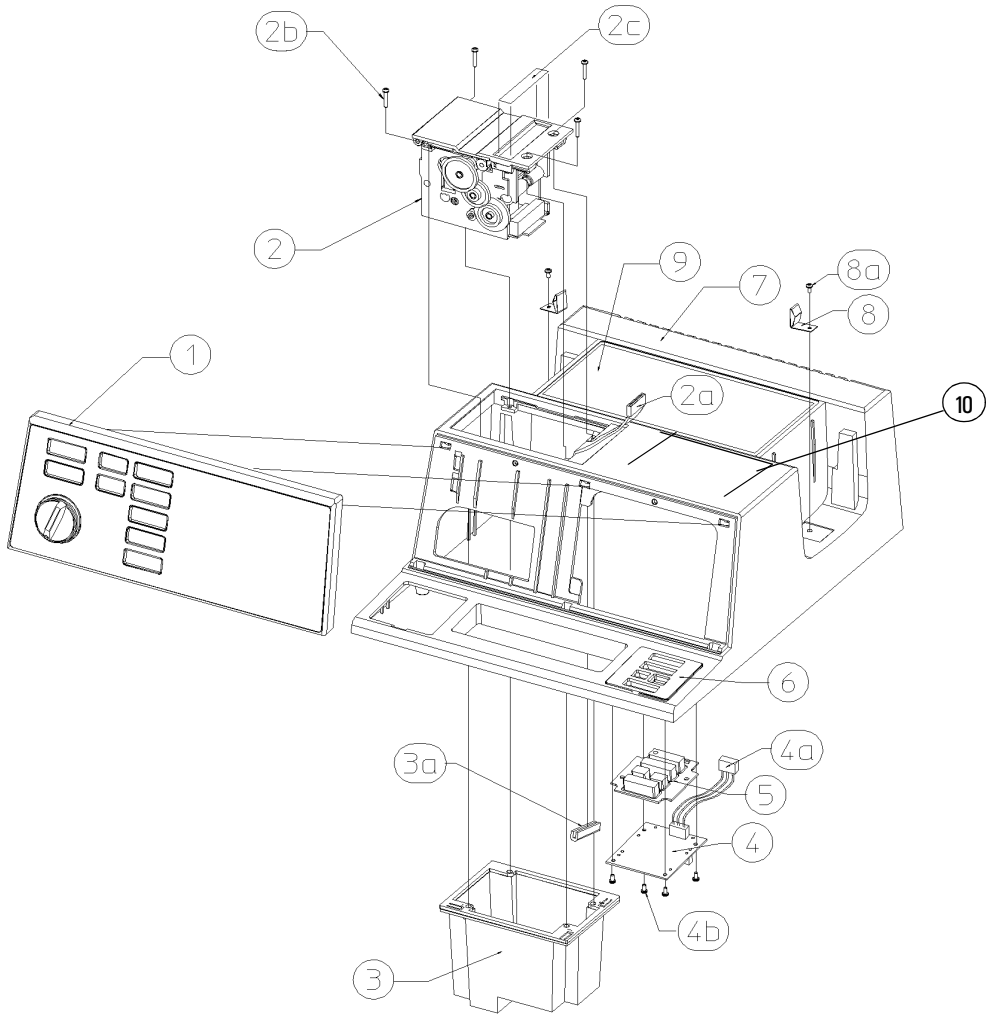
Germany	**Italy**
Tel: 0130-4730	**Tel: 0292 122999**

Netherlands	**United Kingdom**
Tel: (0) 20-547-6333	**Tel: 44-344-36633**

Belgium	
Tel: 32 2 778 35 31	

In other countries, contact your local service office. Consult the listing at the back of this manual for office locations and information.

Figure 6-1



Top Case Parts List

Table 6-1 Top Case Parts List

Ref. No.	Description	Part No.	Part No. With Shock Advisory
1	Keypanel assembly part numbers.	See Table 6-5.	
1	Keypanel assembly without SpO_2—English, (M1722A/B)	M1722-69500	M1722-69610
	Keypanel assembly without SpO_2—French, (M1722A/B)	M1722-69501	M1722-69611
	Keypanel assembly without SpO_2—German, (M1722A/B)	M1722-69502	M1722-69612
	Keypanel assembly without SpO_2—Dutch, (M1722A/B)	M1722-69503	M1722-69613
	Keypanel assembly without SpO_2—Spanish, (M1722A/B)	M1722-69504	M1722-69614
	Keypanel assembly without SpO_2—Italian, (M1722A/B)	M1722-69505	M1722-69615
	Keypanel assembly without SpO_2—Swedish, (M1722A/B)	M1722-69506	M1722-69616
	Keypanel assembly without SpO_2—Japanese, (M1722A/B)	M1722-69507	M1722-69617

Table 6-1 Top Case Parts List

Ref. No.	Description	Part No.	Part No. With Shock Advisory
1	Keypanel assembly without SpO_2—Norwegian, (M1722A/B)	M1722-69508	M1722-69618
	Keypanel assembly without SpO_2—Finnish, (M1722A/B)	M1722-69509	M1722-69619
	Keypanel assembly without SpO_2—Danish, (M1722A/B)	M1722-69510	M1722-69620
1	Keypanel assembly with SpO_2—English (M1722A/B)	M1722-69650	M1722-69630
	Keypanel assembly with SpO_2—French (M1722A/B)	M1722-69651	M1722-69631
	Keypanel assembly with SpO_2—German (M1722A/B)	M1722-69652	M1722-69632
	Keypanel assembly with SpO_2—Dutch (M1722A/B)	M1722-69653	M1722-69633
	Keypanel assembly with SpO_2—Spanish (M1722A/B)	M1722-69654	M1722-69634
	Keypanel assembly with SpO_2— Italian (M1722A/B)	M1722-69655	M1722-69635
	Keypanel assembly with SpO_2— Swedish (M1722A/B)	M1722-69656	M1722-69636
	Keypanel assembly with SpO_2— Japanese (M1722A/B)	M1722-69657	M1722-69637
	Keypanel assembly with SpO_2— Norwegian (M1722A/B)	M1722-69658	M1722-69638
	Keypanel assembly with SpO_2— Finnish (M1722A/B)	M1722-69659	M1722-69639
	Keypanel assembly with SpO_2— Danish (M1722A/B)	M1722-69660	M1722-69640
1	Keypanel assembly without SpO_2—English, (M1723A/B)	M1723-69510	M1723-69610
	Keypanel assembly without SpO_2—French, (M1723A/B)	M1723-69511	M1723-69611
	Keypanel assembly without SpO_2—German, (M1723A/B)	M1723-69512	M1723-69612
	Keypanel assembly without SpO_2—Dutch, (M1723A/B)	M1723-69513	M1723-69613
	Keypanel assembly without SpO_2—Spanish, (M1723A/B)	M1723-69514	M1723-69614
	Keypanel assembly without SpO_2—Italian, (M1723A/B)	M1723-69515	M1723-69615
	Keypanel assembly without SpO_2—Swedish, (M1723A/B)	M1723-69516	M1723-69616
	Keypanel assembly without SpO_2—Japanese, (M1723A/B)	M1723-69517	M1723-69617
	Keypanel assembly without SpO_2—Norwegian, (M1723A/B)	M1723-69518	M1723-69618
	Keypanel assembly without SpO_2—Finnish, (M1723A/B)	M1723-69519	M1723-69619
	Keypanel assembly without SpO_2—Danish, (M1723A/B)	M1723-69520	M1723-69620
1	Keypanel assembly with SpO_2—English (M1723A/B)	M1723-69600	M1723-69620
	Keypanel assembly with SpO_2—French (M1723A/B)	M1723-69601	M1723-69630
	Keypanel assembly with SpO_2—German (M1723A/B)	M1723-69602	M1723-69631
	Keypanel assembly with SpO_2—Dutch (M1723A/B)	M1723-69603	M1723-69632
	Keypanel assembly with SpO_2—Spanish (M1723A/B)	M1723-69604	M1723-69633
	Keypanel assembly with SpO_2—Italian (M1723A/B)	M1723-69605	M1723-69634
	Keypanel assembly with SpO_2—Swedish (M1723A/B)	M1723-69606	M1723-69635
	Keypanel assembly with SpO_2—Japanese (M1723A/B)	M1723-69607	M1723-69636
	Keypanel assembly with SpO_2—Norwegian (M1723A/B)	M1723-69608	M1723-69637
	Keypanel assembly with SpO_2—Finnish (M1723A/B)	M1723-69609	M1723-69638
	Keypanel assembly with SpO_2—Danish (M1723A/B)	M1723-69610	M1723-69639
2	Recorder assembly (M1722A/B, M1723A/B)	M1722-69520	
2a	Cable, recorder	M1722-61618	

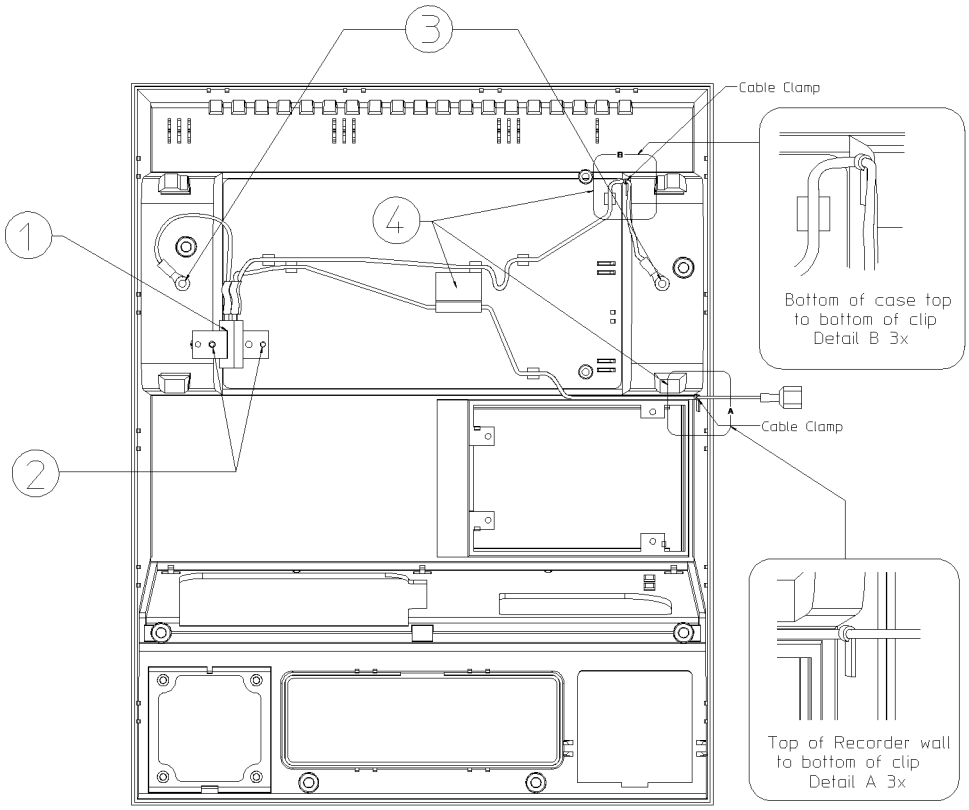
Table 6-1 Top Case Parts List

Ref. No.	Description	Part No.	Part No. With Shock Advisory
2b	Screw, M3 x 16 (qty.4)	0515-0375	
2c	Printer Label kit (M1722A/B, M1723A/B)	M3500-69559	
3	Bucket assembly (gasket and bucket)	M1722-67460	
3a	Gasket, Recorder Channel	M1722-87906	
4	Pacer keyboard PCA, (M1722A/B)	M1722-60185	
4a	Cable, pacer keyboard	M1722-61605	
4b	Screw, M3 x 10 (qty.4) (Pacer to cover)	0515-0374	
5	Pacer keypad—English, (M1722A/B)	M1722-84410	
	Pacer keypad—French, (M1722A/B)	M1722-84411	
	Pacer keypad—German, (M1722A/B)	M1722-84412	
	Pacer keypad—Dutch, (M1722A/B)	M1722-84413	
	Pacer keypad—Spanish, (M1722A/B)	M1722-84414	
	Pacer keypad—Italian, (M1722A/B)	M1722-84415	
	Pacer keypad—Swedish, (M1722A/B)	M1722-84416	
	Pacer keypad—Japanese, (M1722A/B)	M1722-84417	
	Pacer keypad—Norwegian, (M1722A/B)	M1722-84440	
	Pacer keypad—Finnish, (M1722A/B)	M1722-84441	
	Pacer keypad—Danish, (M1722A/B)	M1722-84442	
6	Bezel—pacer (white), (M1722A)	M1722-47221	
	Bezel—pacer (yellow), (M1722B)	M1722-47291	
	Bezel—no pacer (white), (M1722A, M1723A)	M1722-47209	
	Bezel—no pacer (yellow), (M1722B, M1723B)	M1722-47299	
7	Cover, top (white), (M1722A, M1723A) (Requires case label set)	M1722-47200	
	Cover, top (yellow), (M1722B M1723B) (Requires case label set)	M1722-47290	
8	Contactor, paddle	M1722-04701	
8a	Screw—M3 x 4 (Paddle retainers)	0515-0663	
	* The white and yellow printer cables are contained in the Printer Label Kit	M3500-69559	

Table 6-1 Top Case Parts List

Ref. No.	Description	Part No.	Part No. With Shock Advisory
9	Case labels—English (white), (M1722A, M1723A)	M1722-84510	
	Case labels—French (white), (M1722A, M1723A)	M1722-84511	
	Case labels—German (white), (M1722A, M1723A)	M1722-84512	
	Case labels—Dutch (white), (M1722A, M1723A)	M1722-84513	
	Case labels—Spanish (white), (M1722A, M1723A)	M1722-84514	
	Case labels—Italian (white), (M1722A, M1723A)	M1722-84515	
	Case labels—Swedish (white), (M1722A, M1723A)	M1722-84516	
	Case labels—Japanese (white), (M1722A, M1723A)	M1722-84517	
	Case labels—Norwegian (white), (M1722A, M1723A)	M1722-84550	
	Case labels—Finnish (white), (M1722A, M1723A)	M1722-84551	
	Case labels—Danish (white), (M1722A, M1723A)	M1722-84552	
9	Case labels—English (yellow), (M1722B, M1723B)	M1722-84210	
	Case labels—French (yellow), (M1722B, M1723B)	M1722-84211	
	Case labels—German (yellow), (M1722B, M1723B)	M1722-84212	
	Case labels—Dutch (yellow), (M1722B, M1723B)	M1722-84213	
	Case labels—Spanish (yellow), (M1722B, M1723B)	M1722-84214	
	Case labels—Italian (yellow), (M1722B, M1723B)	M1722-84215	
	Case labels—Swedish (yellow), (M1722B, M1723B)	M1722-84216	
	Case labels—Japanese (yellow), (M1722B, M1723B)	M1722-84217	
	Case labels—Norwegian (yellow), (M1722B, M1723B)	M1722-84240	
	Case labels—Finnish (yellow), (M1722B, M1723B)	M1722-84241	
	Case labels—Danish (yellow), (M1722B, M1723B)	M1722-84242	
10	Advisory Mode Instruction Label English		M1722-84120
	Advisory Mode Instruction Label French		M1722-84121
	Advisory Mode Instruction Label German		M1722-84122
	Advisory Mode Instruction Label Dutch		M1722-84123
	Advisory Mode Instruction Label Spanish		M1722-84124
	Advisory Mode Instruction Label Italian		M1722-84125
	Advisory Mode Instruction Label Swedish		M1722-84126
	Advisory Mode Instruction Label Japanese		M1722-84127
	Advisory Mode Instruction Label Norwegian		M1722-84128
	Advisory Mode Instruction Label Finnish		M1722-84129
	Advisory Mode Instruction Label Danish		M1722-84130

Figure 6-2

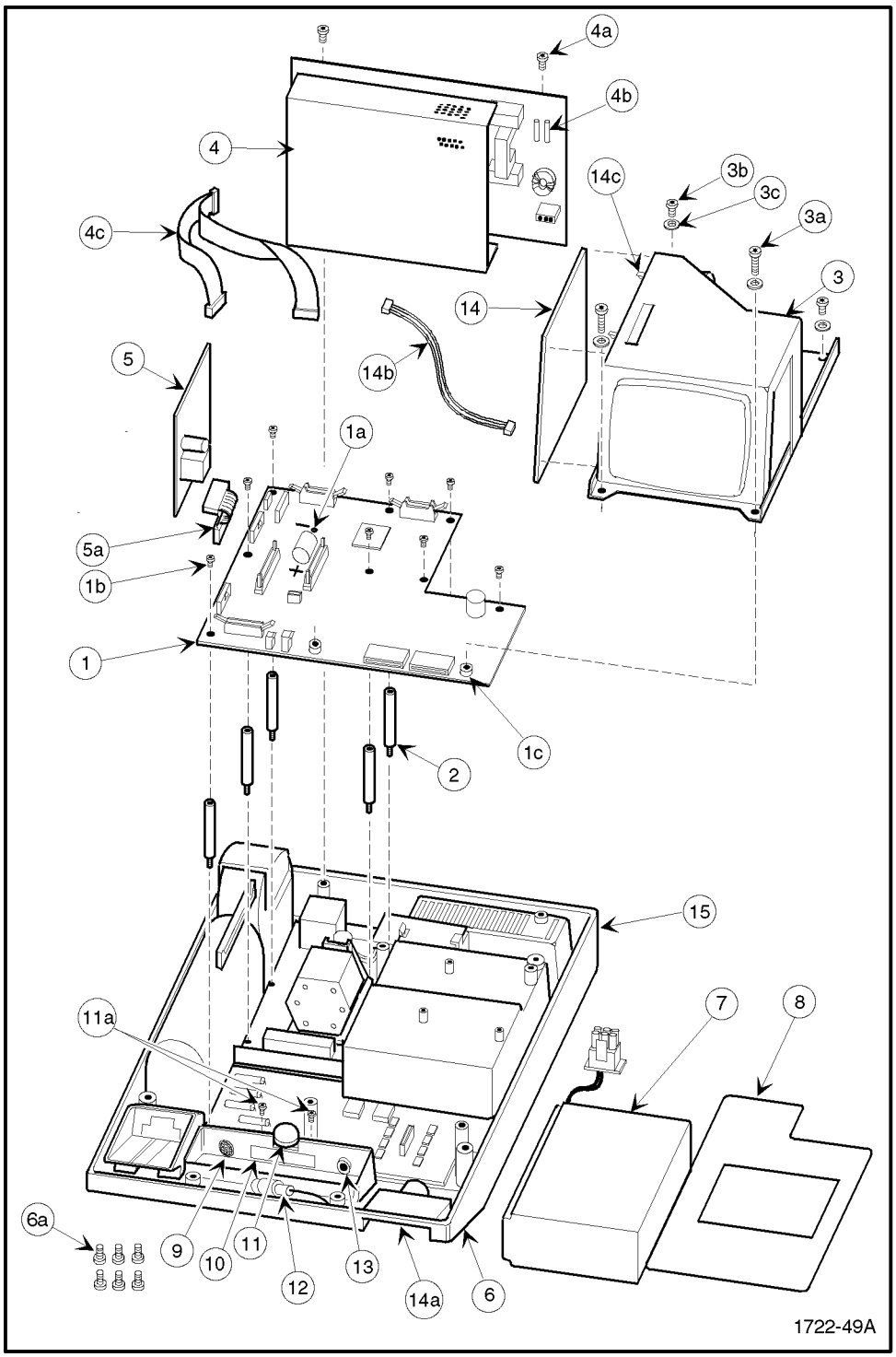


Top Case—Inside

Table 6-2 **Top Case—Inside Parts List**

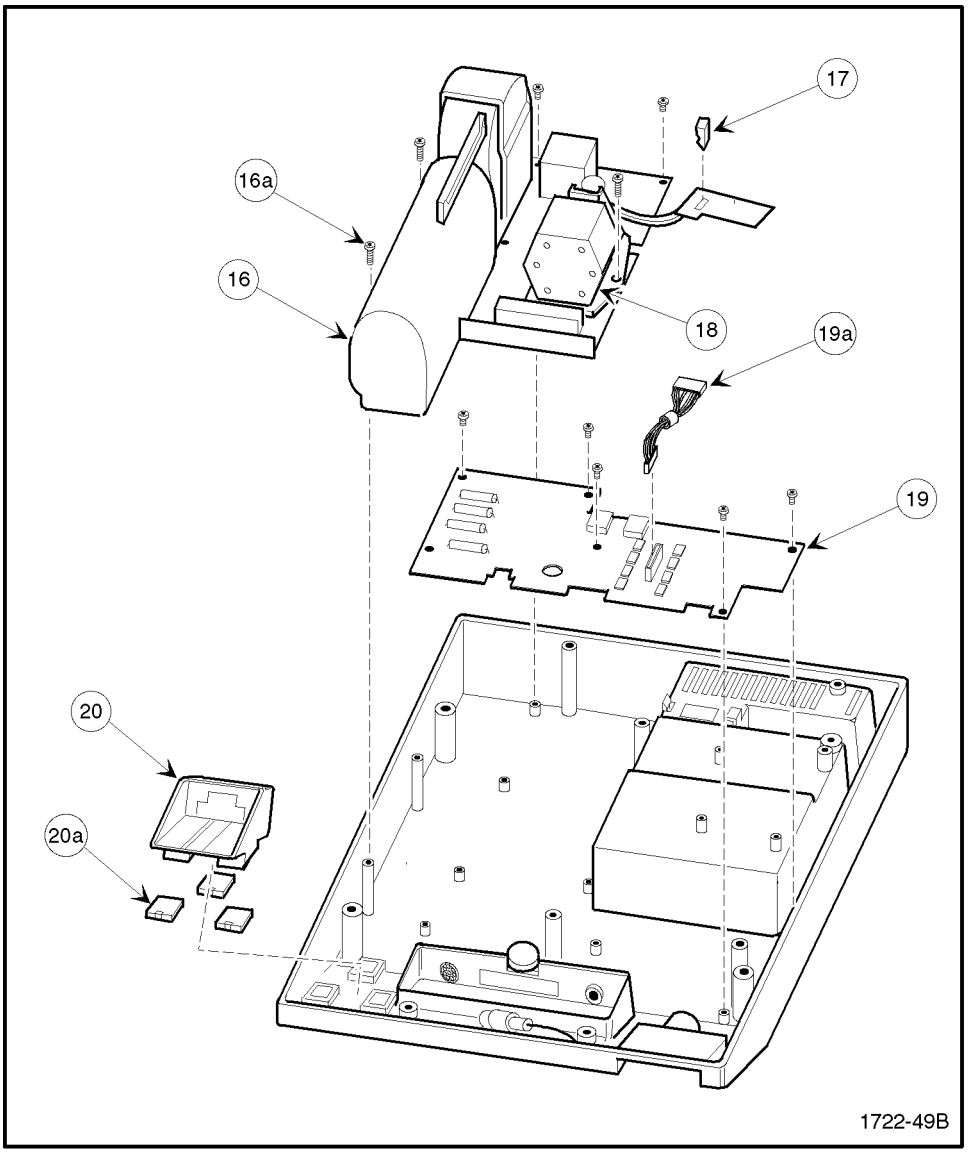
Ref. No.	Description	Part No.
1	Resistor assembly, patient load	M1722-60010
2	Screw, M3 x 10 (qty. 2)	0515-0374
3	Screw, M3 x 4 (qty. 2)	0515-0663
4	Cable clamp (qty. 3)	1400-1568

Figure 6-3



Bottom Case

Figure 6-4



Bottom Case

Table 6-3 **Bottom Case Parts List**

Ref. No.	Description	Part No.
1	Control PCA, (M1722A/B, M1723A/B)	M1722-60103
1a	Battery, lithium 3V, 1.2AH	1420-0341
1b	Screw, M3 x 10 (qty. 8)	0515-0374
1c	Press-fit standoffs	M1722-27302

Table 6-3 **Bottom Case Parts List**

Ref. No.	Description	Part No.
2	Standoff, insulated (qty. 5)	M1722-47277
3	CRT Assembly, (M1722A/B, M1723A/B)	M1722-67210
3a	Screw, M4 x 18	0515-0436
3b	Screw, M4 x 10	0515-0380
3c	Washer (qty. 4)	2190-0419 See Table 6-7
4	Power Supply assembly	M1722-69530
4a	Screw, M4 x 10 (qty. 2)	0515-0380
4b	Fuse, 4A 250V Fast	2110-0055
4c	Power supply cable	M1722-61606
5	Pacer PCA, (M1722A/B)	M1722-60170
5a	Cable, Pacer/Control	M1722-61617
6	Case, bottom (white), (M1722A, M1723A) (Requires case label set, see Table 6-1.) (Includes feet, battery compartment pad, receptacle pads, two plugs and SpO_2 case labels.)	M1722-69561
	Case, bottom (yellow), (M1722B, M1723B) (Requires case label set, see Table 6-1.) (Includes feet, battery compartment pad, receptacle pads, two plugs and SpO_2 case labels.)	M1722-69562
	Foot, plastic, (qty. 4)	0403-0767
	Pad, Battery Compartment	M1722-47213
	SpO_2 Case Labels (White, English)	M1722-84553
	SpO_2 Case Labels (White, International)	M1722-84554
	SpO_2 Case Labels (Yellow, English)	M1722-84555
	SpO_2 Case Labels (Yellow, International)	M1722-84556
	Plug—No SpO_2 (Yellow)	M1722-47103
	Plug—No SpO_2 (white)	M1724-47101
6a	Screw, M4 x 10 (qty. 6)	0515-0380
7	Battery assembly, lead-acid	M1758A

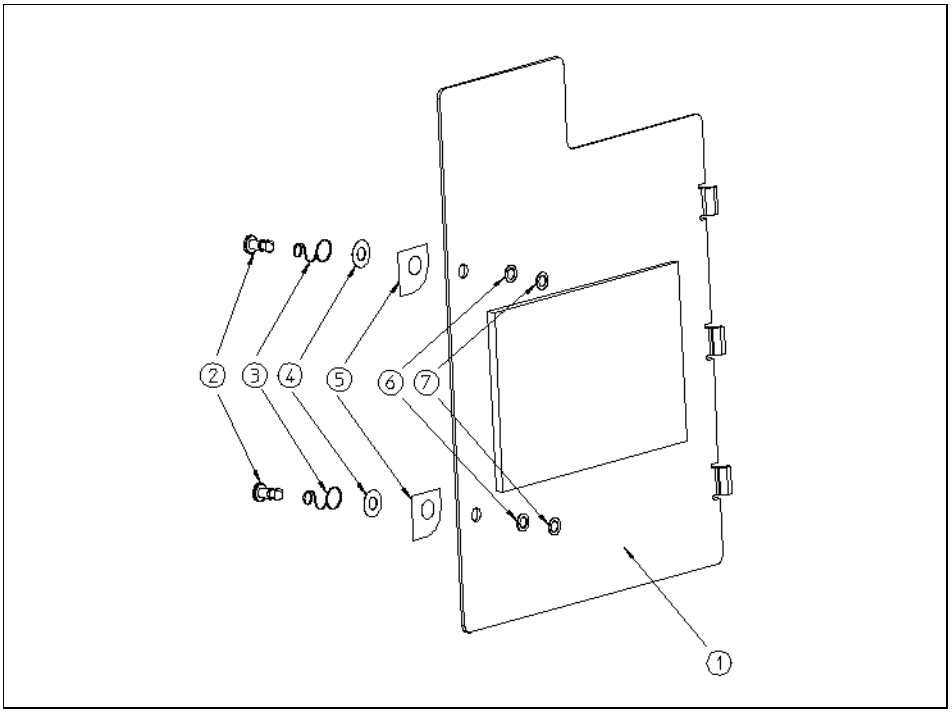
Table 6-3 **Bottom Case Parts List**

Ref. No.	Description	Part No.
8	Battery door assembly (white), (M1722A, M1723A) (Requires case label set, see Table 6-1.)	M1722-62720
	Battery door assembly (yellow), (M1722B, M1723B) (Requires case label set, see Table 6-1.)	M1722-62790 See Table 6-4
9	ECG In cable, 6-pin	M1722-61614
	ECG In cable, 8-pin	M1722-61615
	ECG In cable, 12-pin	M1722-61616
10	Label (part of case label set)	See Table 6-1.
11	QRS volume control assembly	M1722-61910
11a	Screw, M3 x 10 (qty. 2)	0515-0374
12	Beeper	M1722-61632
13	Cable—ECG Out/Sync	M1722-61624
13a	Ring nut 3/8 in (not shown)	0590-0856
13b	Lockwasher, 3/8 in (not shown)	2190-0579
14	SpO_2 PCA	M1722-60102
14a	SpO_2 Connector	M1722-61651
14b	SpO_2 to keyboard cable	M1722-61652
14c	Tie locks (set of 5)	5180-2105
14d	Insulator, mylar (not shown)	M1722-87913
15	AC input receptacle	M1722-61607
16	High Voltage Assembly, (M1722A/B, M1723A/B)	See Table 6-6
16a	Screw, M3 x 10 (qty. 4)	0515-0374
17	Plug, Securing (Battery connector)	M1722-47241
18	Patient Relay Assembly	See Table 6-6.
19	Front End PCA, (M1722A/B, M1723A/B)	M1722-60120
19a	Cable—Front End/Control	M1722-61611
20	Receptacle assembly—paddle (includes 14a - 14d)	M1722-61626
20a	Pad (qty. 3)	M1722-47237
20b	Cable, paddle receptacle (not shown)	M1722-61620
20c	Receptacle, body (not shown)	M1722-47204

Table 6-3 **Bottom Case Parts List**

Ref. No.	Description	Part No.
20d	Screw, tapping 2-28 (not shown)	0624-0612
21	Ground lug (not shown)	1251-5964
21a	Washer, flat (not shown)	78620-00849
21b	Nut, hex (qty. 2)(not shown)	0590-0565
21c	Washer, lock (not shown)	2190-0084

Figure 6-5

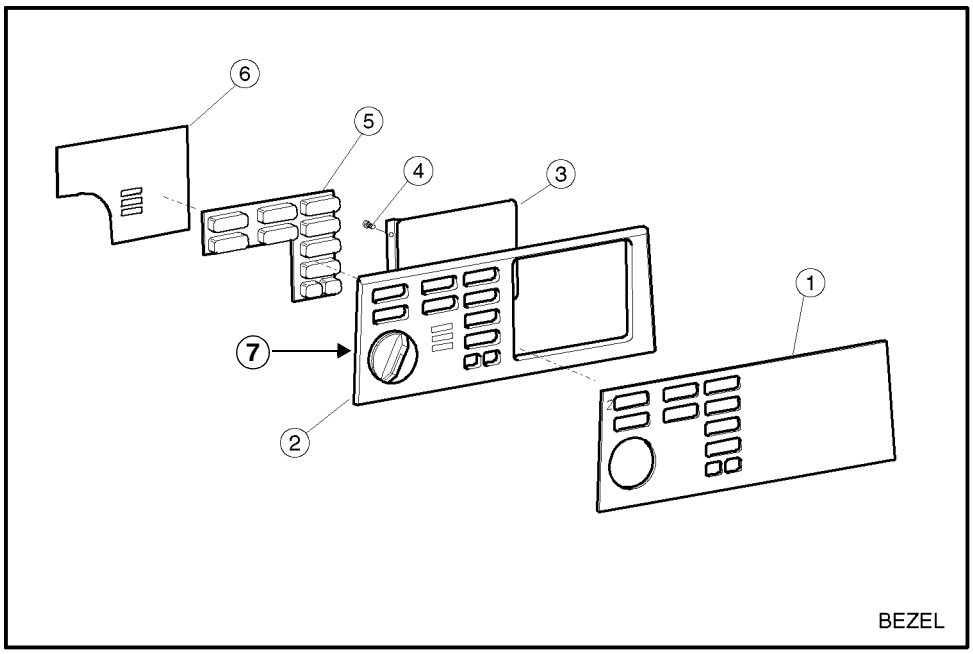


Battery Door Assembly

Table 6-4 **Battery Door Assembly Parts List**

Ref. No.	Description	Part No.
1	Battery door assembly (white), (M1722A, M1723A) (includes items numbered 2 through 7)	M1722-62720
	Battery door assembly (yellow), (M1722B, M1723B) (includes items numbered 2 through 7)	M1722-62790
2	Fastener, 1/4 turn (qty. 2)	1390-1004
3	Spring (qty. 2)	1460-2348
4	Washer, nylon (qty. 2)	3050-1400
5	Labels, door lock (qty. 2)	M1722-84538
6	Washer, split	1390-0435
7	Washer, nylon	1390-1005
8	Label (Part of case label set)	See Table 6-1

Figure 6-6



Key Panel Assembly

Table 6-5 Keypanel Assembly Parts List

Ref. No.	Description	Part No.	Shock Advisory Part No.
1	Keylabel without SpO_2—English (M1722A/B)	M1722-84530	M1722-84900
	Keylabel without SpO_2—French (M1722A/B)	M1722-84531	M1722-84901
	Keylabel without SpO_2—German (M1722A/B)	M1722-84532	M1722-84902
	Keylabel without SpO_2—Dutch (M1722A/B)	M1722-84533	M1722-84903
	Keylabel without SpO_2—Spanish (M1722A/B)	M1722-84534	M1722-84904
	Keylabel without SpO_2—Italian (M1722A/B)	M1722-84535	M1722-84905
	Keylabel without SpO_2—Swedish (M1722A/B)	M1722-84536	M1722-84906
	Keylabel without SpO_2—Japanese (M1722A/B)	M1722-84537	M1722-84907
	Keylabel without SpO_2—Norwegian (M1722A/B)	M1722-84570	M1722-84908
	Keylabel without SpO_2—Finnish (M1722A/B)	M1722-84571	M1722-84909
	Keylabel without SpO_2—Danish (M1722A/B)	M1722-84572	M1722-84910

Table 6-5 Keypanel Assembly Parts List

Ref. No.	Description	Part No.	Shock Advisory Part No.
1	Keylabel with SpO_2—English (M1722A/B)	M1722-84600	M1722-84920
	Keylabel with SpO_2—French (M1722A/B)	M1722-84601	M1722-84921
	Keylabel with SpO_2—German (M1722A/B)	M1722-84602	M1722-84922
	Keylabel with SpO_2—Dutch (M1722A/B)	M1722-84603	M1722-84923
	Keylabel with SpO_2—Spanish (M1722A/B)	M1722-84604	M1722-84924
	Keylabel with SpO_2—Italian (M1722A/B)	M1722-84605	M1722-84925
	Keylabel with SpO_2—Swedish (M1722A/B)	M1722-84606	M1722-84926
	Keylabel with SpO_2—Japanese (M1722A/B)	M1722-84607	M1722-84927
	Keylabel with SpO_2—Norwegian (M1722A/B)	M1722-84608	M1722-84928
	Keylabel with SpO_2—Finnish (M1722A/B)	M1722-89609	M1722-89429
	Keylabel with SpO_2—Danish (M1722A/B)	M1722-84610	M1722-84930
1	Keylabel without SpO_2—English (M1723A/B)	M1723-84330	M1723-84900
	Keylabel without SpO_2—French (M1723A/B)	M1723-84331	M1723-84901
	Keylabel without SpO_2—German (M1723A/B)	M1723-84332	M1723-84902
	Keylabel without SpO_2—Dutch (M1723A/B)	M1723-84333	M1723-84903
	Keylabel without SpO_2—Spanish (M1723A/B)	M1723-84334	M1723-84904
	Keylabel without SpO_2—Italian (M1723A/B)	M1723-84335	M1723-84905
	Keylabel without SpO_2—Swedish (M1723A/B)	M1723-84336	M1723-84906
	Keylabel without SpO_2—Japanese (M1723A/B)	M1723-84337	M1723-84907
	Keylabel without SpO_2—Norwegian (M1723A/B)	M1723-84338	M1723-84908
	Keylabel without SpO_2—Finnish (M1723A/B)	M1723-84339	M1723-84909
	Keylabel without SpO_2—Danish (M1723A/B)	M1723-84340	M1723-84910

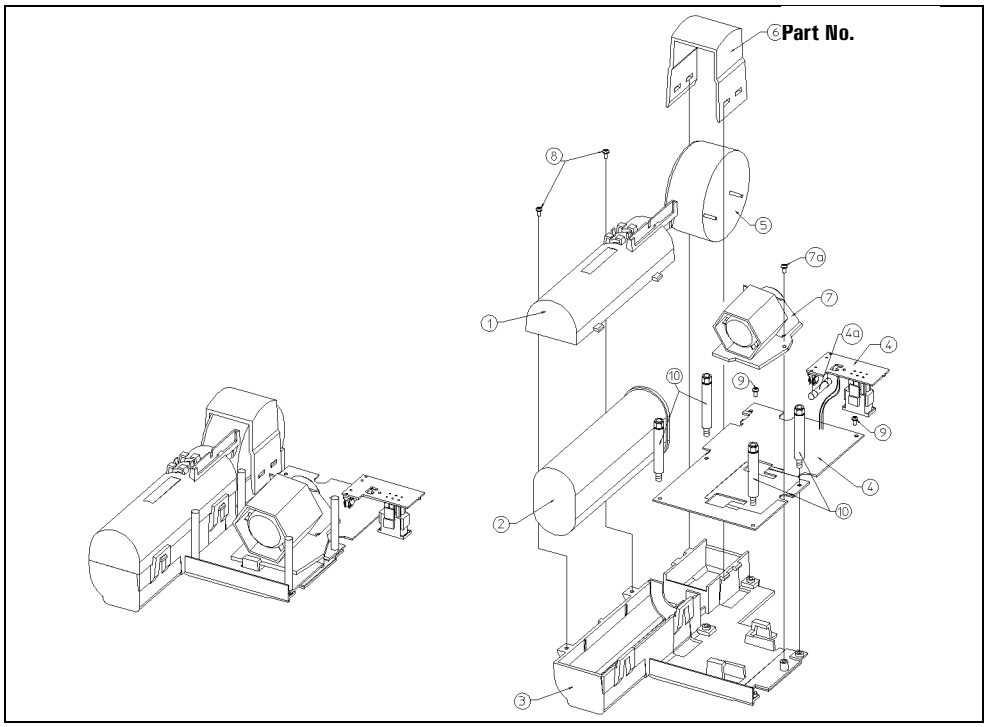
Table 6-5 Keypanel Assembly Parts List

Ref. No.	Description	Part No.	Shock Advisory Part No.
1	Keylabel with SpO_2—English (M1723A/B)	M1723-84420	M1723-84920
	Keylabel with SpO_2—French (M1723A/B)	M1723-84421	M1723-84921
	Keylabel with SpO_2—German (M1723A/B)	M1723-84422	M1723-84922
	Keylabel with SpO_2—Dutch (M1723A/B)	M1723-84423	M1723-84923
	Keylabel with SpO_2—Spanish (M1723A/B)	M1723-84424	M1723-84924
	Keylabel with SpO_2—Italian (M1723A/B)	M1723-84425	M1723-84925
	Keylabel with SpO_2—Swedish (M1723A/B)	M1723-84426	M1723-84926
	Keylabel with SpO_2—Japanese (M1723A/B)	M1723-84427	M1723-84927
	Keylabel with SpO_2—Norwegian (M1723A/B)	M1723-84428	M1723-84928
	Keylabel with SpO_2—Finnish (M1723A/B)	M1723-84429	M1723-84929
	Keylabel with SpO_2—Danish (M1723A/B)	M1723-84430	M1723-84930
2	Bezel/Energy select switch with/without SpO_2 (M1722A/B, M1723A/B)	M1722-67225	
3	Lens—CRT	M1722-47501	
4	Screw, M3 x 10 (qty. 2)	0515-0374	
5	Keypad[1]—English, (M1722A/B, M1723A/B)		M1722-84450
	Keypad[1]—French, (M1722A/B, M1723A/B)		M1722-84451
	Keypad[1]—German, (M1722A/B, M1723A/B)		M1722-84452
	Keypad[1]—Dutch, (M1722A/B, M1723A/B)		M1722-84453
	Keypad[1]—Spanish, (M1722A/B, M1723A/B)		M1722-84454
	Keypad[1]—Italian, (M1722A/B, M1723A/B)		M1722-84455
	Keypad[1]—Swedish, (M1722A/B, M1723A/B)		M1722-84456
	Keypad[1]—Japanese, (M1722A/B,M1723A/B)		M1722-84457
	Keypad[1]—Norwegian, (M1722A/B, M1723A/B)		M1722-84458
	Keypad[1]—Finnish, (M1722A/B, M1723A/B)		M1722-84459
	Keypad[1]—Danish, (M1722A/B, M1723A/B)		M1722-84460
6	Keypanel, PCA[2] (comes with cable M1722-61604)		M1722-60195
7	Rotary Switch		M1722-61900

[1] The keypad may include more keys than the instrument allows. Cut out all unnecessary keys. The cut should be made to leave a hole in place of the key.

[2] This Keypanel PCA is used in both the M1722 and M1723. To use this keypanel in the M1723A/B, you must first cut a trace on the circuit board. See “Removing and Disassembling the Keypanel Assembly” on page 5-7 for detailed information.

Figure 6-7



High Voltage Assembly

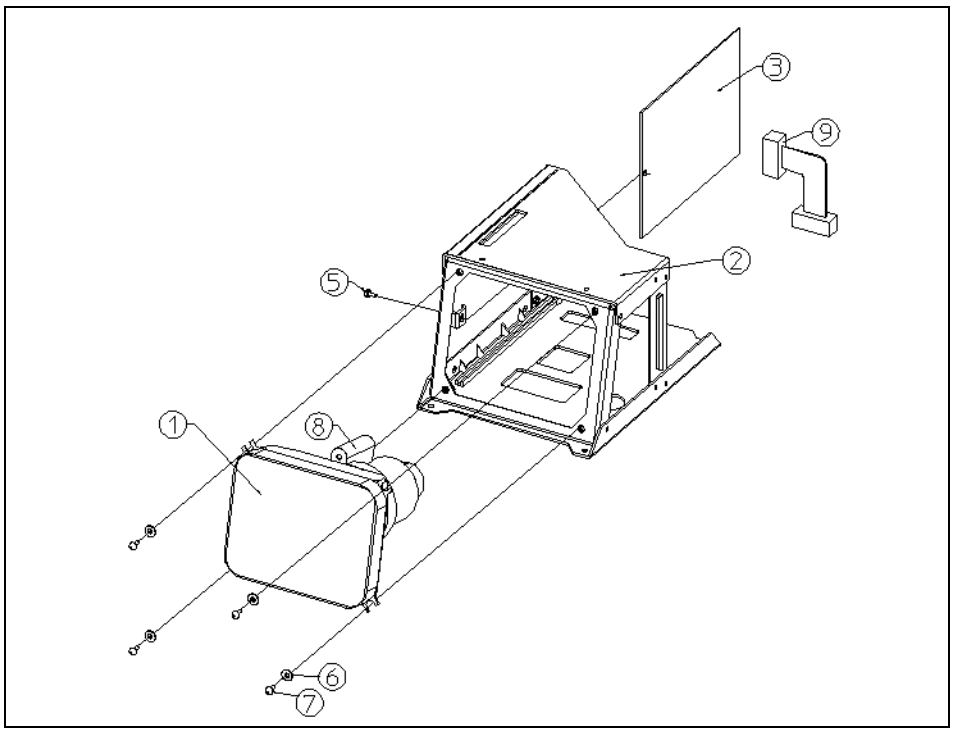
Table 6-6 **High Voltage Assembly Parts List**

Ref. No.	Description	Part No.
1	HV Capacitor Retainer	M1722-67304
2	HV Capacitor	M1722-82801
3	HV Retainer	M1722-47305
4	High Voltage PCA (includes battery board)	M1722-60110
4a	Fuse, 25A, 32V	2110-0250
5	Inductor	M1722-82800
6	Inductor Retainer	M1722-47306
7	Patient Relay Assembly (includes patient relay and bracket)	M1722-62805
	Relay, Patient	M1722-82806
	Relay Bracket	M1722-01205
7a	Screw, M3x16 (qty. 1)	0515-0375

Table 6-6 **High Voltage Assembly Parts List**

Ref. No.	Description	Part No.
8, 9	Screw—M3 x 10 (qty. 4)	0515-0374
10	Stand-offs (qty. 4)	M1722-47227

Figure 6-8



CRT Assembly

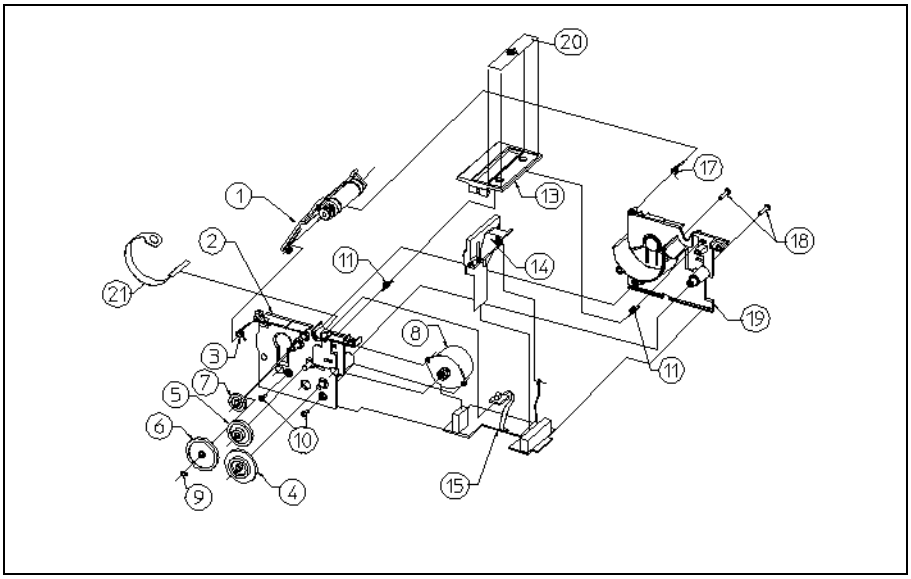
Table 6-7 **CRT Assembly Parts List**

Ref. No.	Description	Part No.
	CRT Assembly (M1722A/B) (M1723A/B) (includes items 1 through 8)	M1722- 67210
1	CRT Tube	M1722-62810
2	CRT Chassis	M1722-07301
3	Deflection PCA	M1722-60130
5	Screw—M3x10 (qty. 1)	0515-0374
6	Washer, flat (qty. 4)	2190-0419

Table 6-7 **CRT Assembly Parts List**

Ref. No.	Description	Part No.
7	Screw—M4x10 (qty. 4)	0515-0380
8	Yoke	5062-2112
9	Cable—CRT/Control	M1722-61619

Figure 6-9



Recorder Assembly

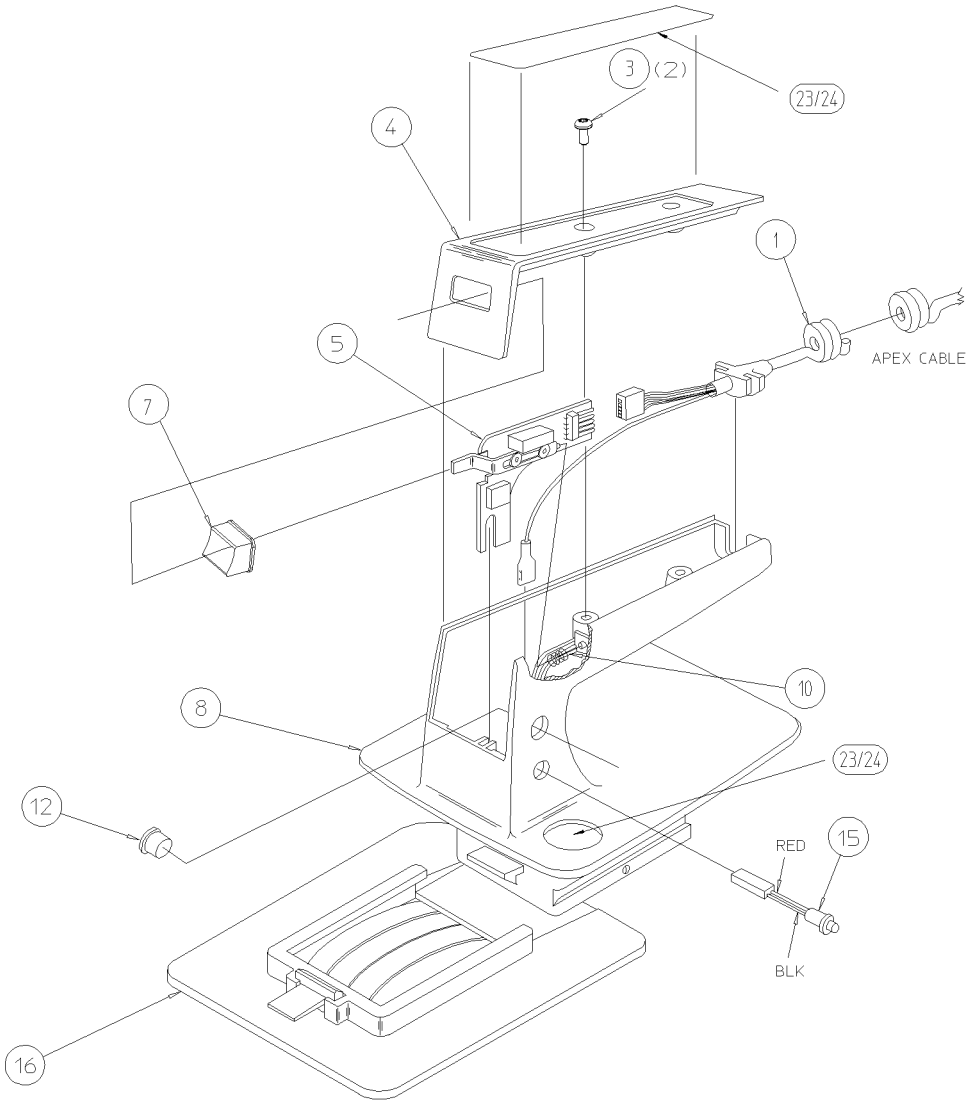
Table 6-8 **Recorder Assembly Parts List**

Ref. No.	Description	Part No.
	Recorder Assembly (white & yellow), (M1722A/B, M1723A/B), (include items numbered 1 through 21)	M1722-69520
1	Platen/door assembly (white), (M1722A, M1723A)	M1722-67410
	Platen/door assembly (yellow), (M1722B, M1723B)	M1722-67491
2	Right chassis	M1722-67303
3	Spring—door, right	M1722-27413
4	Gear, #1-64/40	M1722-47401
5	Gear, #2-50/20	M1722-47402
6	Gear, #3-64/16	M1722-47403
7	Gear, #4-32	M1722-47404
8	Motor assembly	M1700-67403
9	Retaining ring	0510-0238
10	Screw, M3 x 6 (qty. 2)	0515-0430
11	Spring, extension (qty. 2)	M1722-27418

Table 6-8 **Recorder Assembly Parts List**

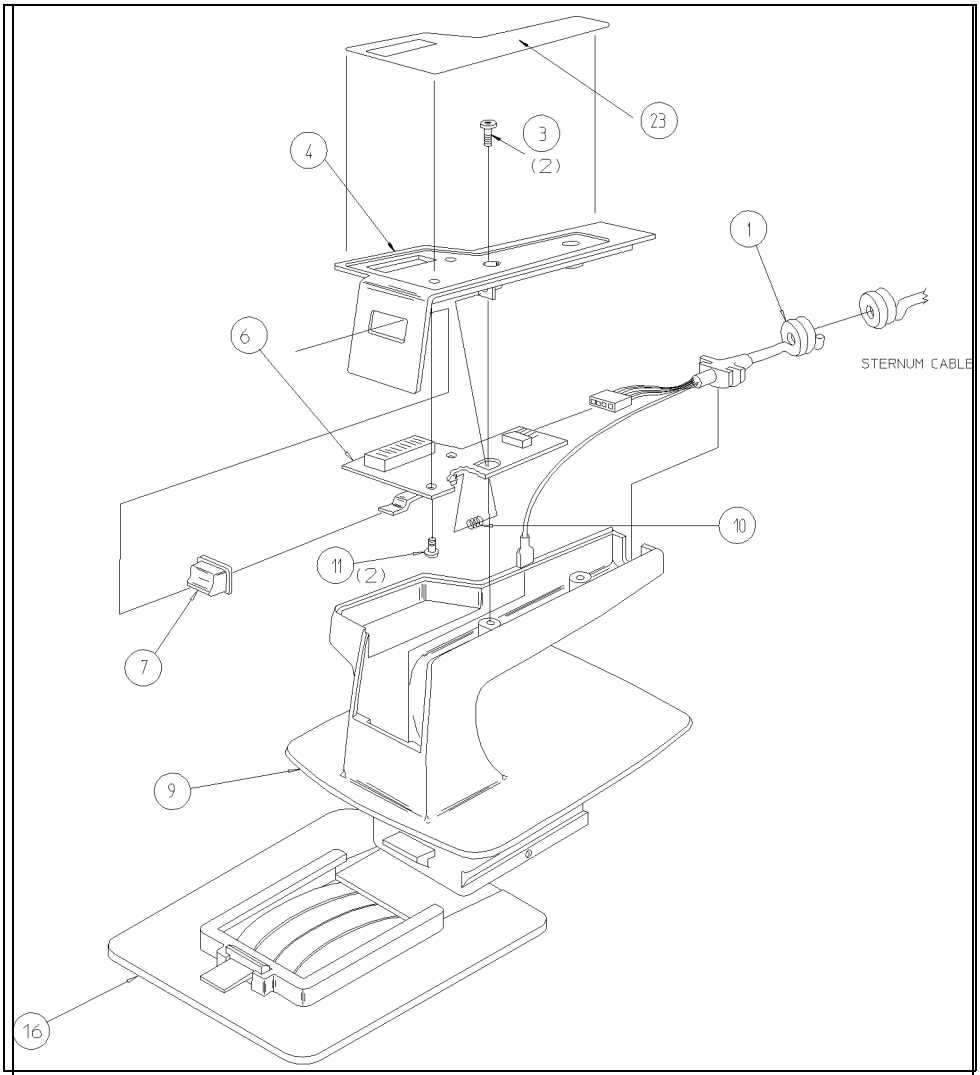
Ref. No.	Description	Part No.
13	Door—sliding (white), (M1722A, M1723A)	M1722-47211
	Door—sliding (yellow), (M1722B, M1723B)	* M1722-47296
14	Printhead assembly	M1722-67450
15	Recorder PCA	M1722-60155
17	Spring—door, left	M1722-27419
18	Screw, M3 x 16 (qty. 2)	0515-0375
19	Left chassis	M1722-47302
20	Printer Label Kit (M1722A/B, M1723A/B)	M3500-69559
21	Paper ejector	M1722-07452
	Paper, thermal (not shown)	40457C\D
	* The white and yellow printer labels are contained in the Printer Label Kit	M3500-69559

Figure 6-10



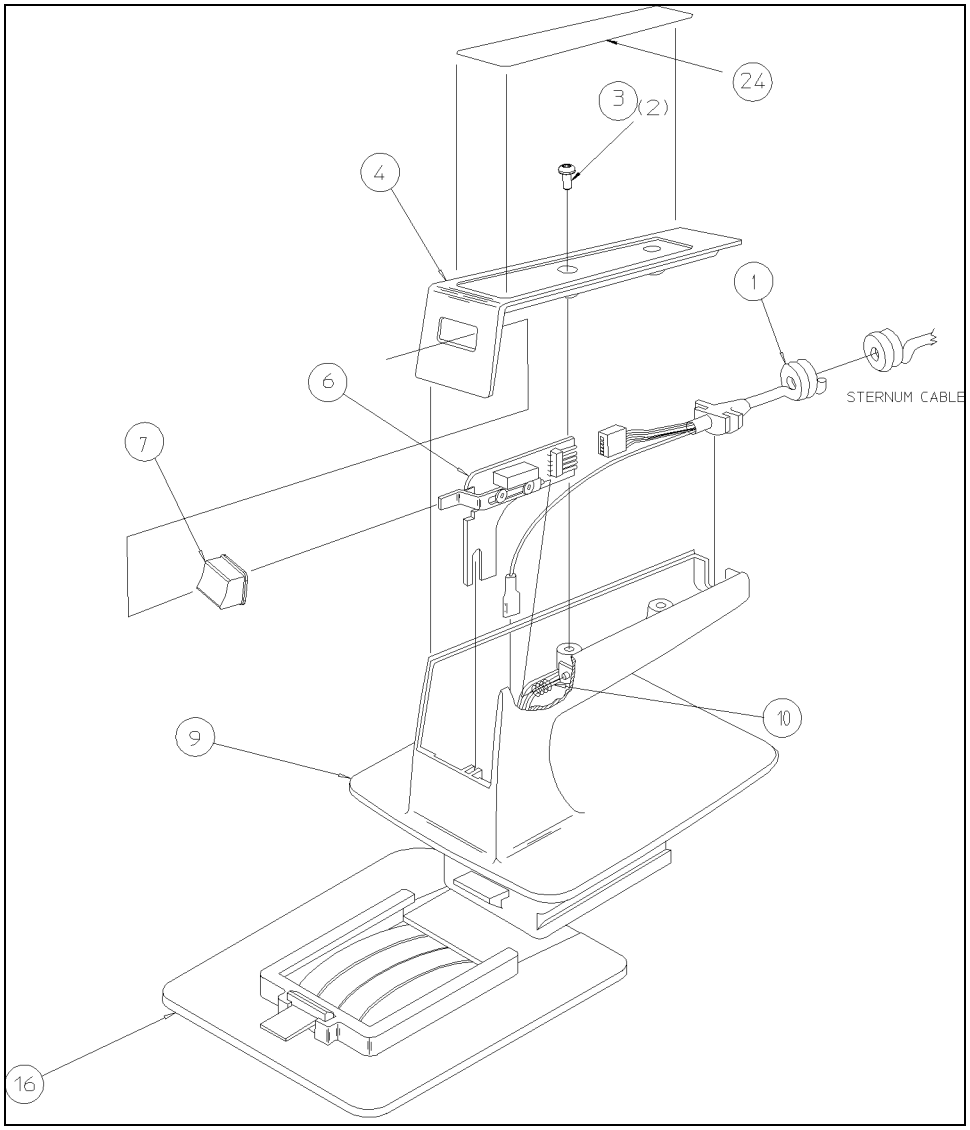
External Paddles Assembly—Apex

Figure 6-11



External Paddles Assembly—Sternum, with PCI

Figure 6-12



External Paddles Assembly—Sternum, without PCI

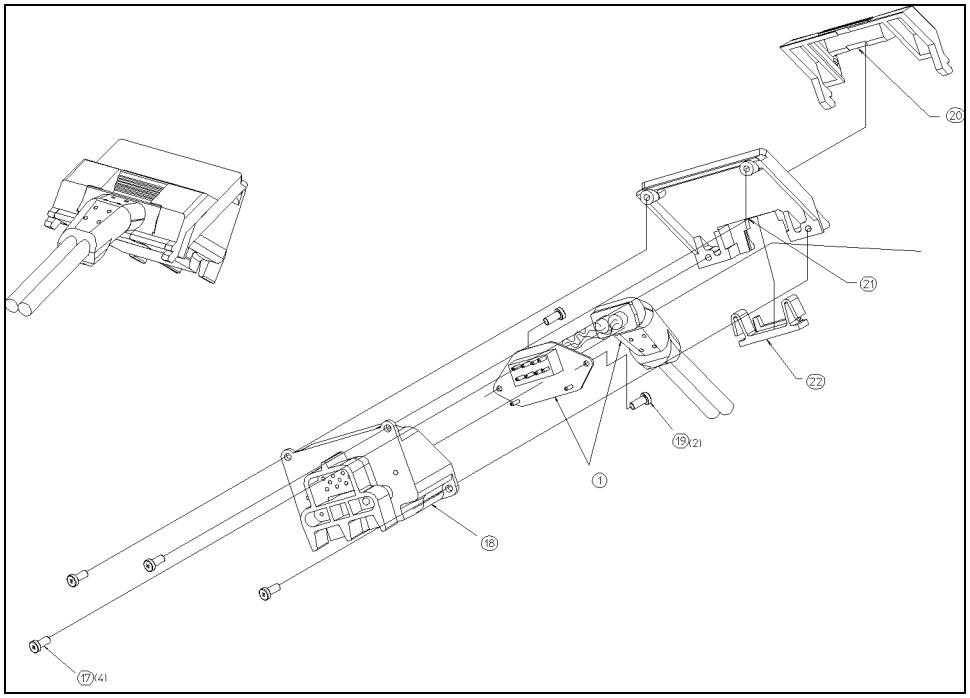
Table 6-9 **Paddle Assembly Parts List**

Ref. No.	Description	Part No.
	Paddle set, Ant/Ant w/PCI (white)	M1746A
	Paddle set, Ant/Ant w/PCI (yellow)	M1746B
	Paddle set, Ant/Ant no PCI (white)	M1747A
	Paddle set, Ant/Ant no PCI (yellow)	M1747B
1	Coil cord (Apex/sternum)	M1746-61600
3	Screw, PHMS 4-40 x 0.375 (qty. 2)	2200-0107
4	Cover - paddle (no PCI) (Apex/Sternum)	M1746-47203
	Cover paddle (with PCI) (Sternum)	M1746-47204
5	PCA - Apex paddle	M1722-60192
6	PCA - Sternum paddle (no PCI)	M1722-60194
	PCA - Sternum paddle (with PCI)	M1722-60190
7	Button, discharge	43100-47121
8	Paddle, Apex	M1746-47201
9	Paddle, Sternum (no PCI)	M1746-47216
	Paddle, Sternum (with PCI)	M1746-47215
10	Spring	43100-87400
11	Screw, PHMS 4-40 x 0.250 (Sternum w/PCI)	2200-0103
12	Charge button	M1746-47213
13	Fiber washer	3052-0682
15	Light indicator	43100-63000
16	Adult Adaptor	M1746-62802

Table 6-9 **Paddle Assembly Parts List**

Ref. No.	Description	Part No.
23	Paddle labels (PCI)—English	M1722-84520
	Paddle labels (PCI)—French	M1722-84521
	Paddle labels (PCI)—German	M1722-84522
	Paddle labels (PCI)—Dutch	M1722-84523
	Paddle labels (PCI)—Spanish	M1722-84524
	Paddle labels (PCI)—Italian	M1722-84525
	Paddle labels (PCI)—Swedish	M1722-84526
	Paddle labels (PCI)—Japanese	M1722-84527
	Paddle labels (PCI)—Norwegian	M1722-84560
	Paddle labels (PCI)—Finnish	M1722-84561
	Paddle labels (PCI)—Danish	M1722-84562
24	Paddle labels (no PCI)—English	M1722-84320
	Paddle labels (no PCI)—French	M1722-84321
	Paddle labels (no PCI)—German	M1722-84322
	Paddle labels (no PCI)—Dutch	M1722-84323
	Paddle labels (no PCI)—Spanish	M1722-84324
	Paddle labels (no PCI)—Italian	M1722-84325
	Paddle labels (no PCI)—Swedish	M1722-84326
	Paddle labels (no PCI)—Japanese	M1722-84327
	Paddle labels (no PCI)—Norwegian	M1722-84360
	Paddle labels (no PCI)—Finnish	M1722-84361
	Paddle labels (no PCI)—Danish	M1722-84362

Figure 6-13



External Paddles Connector Assembly

Table 6-10 **External Paddles Connector Assembly Parts List**

Ref. No.	Description	Part No.
1	Coil cord	M1746-61600
17	Screw, 4-40, tapping (qty. 4)	0624-0600
18	Body, connector	M1722-47203
19	Screw, 2-56, tapping (qty. 2)	0624-0612
20	Latch, sliding (white)	M1746-47307
	Latch, sliding (yellow)	M1746-47397
	Latch, sliding (black)	M1784-45001
21	Cover, paddle connector (white)	M1722-47208
	Cover, paddle connector (yellow)	M1722-47298
	Cover, paddle connector (black)	M1784-47600

Table 6-10 **External Paddles Connector Assembly Parts List**

Ref. No.	Description	Part No.
22	Retainer, strain relief (white)	M1746-47207
	Retainer, strain relief (yellow)	M1746-47297
	Retainer, strain relief (black)	M1784-45002

Table 6-11 **Supplies List**

Description	Part No.
Patient Cables	
Patient cable 6-pin/3-wire AHA	M1731A
Patient cable 6-pin/5-wire AHA	M1732A
Patient cable 8-pin/3-wire AHA	M1733A
Patient cable 8-pin/5-wire AHA	M1734A
Patient cable 8-pin/3-wire IEC	M1735A
Patient cable 8-pin/5-wire IEC	M1736A
Trunk cable 12-pin/3-wire AHA	M1500A
Lead set 3-wire AHA	M1605A
Trunk cable 12-pin/3-wire IEC	M1510A
Lead set 3-wire IEC	M1615A
Trunk cable 12-pin/5-wire AHA	M1520A
Lead set 5-wire AHA	M1625A
Trunk cable 12-pin/5-wire IEC	M1530A
Lead set 5-wire IEC	M1635A
Paddles	
Internal paddle adapter (White)	M1740A
Internal paddle adapter (Yellow)	M1740B
Internal paddle set 7.5cm	M1741A
Internal paddle set 6.0cm	M1742A
Internal paddle set 4.5cm	M1743A
Internal paddle set 2.8cm	M1744A
Anterior/anterior paddle set (white), with PCI	M1746A

Table 6-11 **Supplies List**

Description	Part No.
Anterior/anterior paddle set (yellow), with PCI	M1746B
Anterior/anterior paddle set (white), no PCI	M1747A
Anterior/anterior paddle set (yellow), no PCI	M1747B
Pads	
Defibrillation/Pacing Pads (Adult AAMI)	M3501A
Defibrillation/Pacing Pads (Adult IEC)	M3502A
Defibrillation/Pacing Pads (Pediatric IEC)	M3503A
Defibrillation/Pacing Pads (Pediatric AAMI)	M3504A
Pads adapter (White)	M1750A
Pads adapter (Yellow)	M1750B
Pads adapter test load	M1781A
Battery, lead acid	M1758A
Recorder paper	40457C/D
Carry case	M1778A
Accessory pouch	M1779A
Wall mount hardware	M1722-80001

Cart Parts and Repair

Hewlett-Packard does not repair or supply parts for the MTRO-00336L cart. To obtain information about ordering parts or repair services, contact:

InterMetro Industries Corp.

North Washington Street

P.O. Box A

Wilkes-Barre, PA 18705-0557

Attn: Ben Stepniak, Customer Service

Telephone: 717-825-2741

Theory of Operation

Introduction

This chapter provides theory of operation for the M1722B Defibrillator. The theory describes at a high level the functional operation of the major electronic assemblies (listed below) that make up the defibrillator.

- Control board
- Power supply
- High voltage board
- Patient circuit
- ECG front end board
- CRT module
- Pacer board
- SpO_2 board
- Main keypanel board
- Pacer keypanel board
- Recorder module

These are the primary field-replaceable assemblies. For a complete listing of repair parts available for field repair, refer to Chapter 6, Parts Lists.

Circuit References

Components are usually referred to by the component's function (such as the Defibrillator processor). References more specific than that are to individual diagrams that accompany the text.

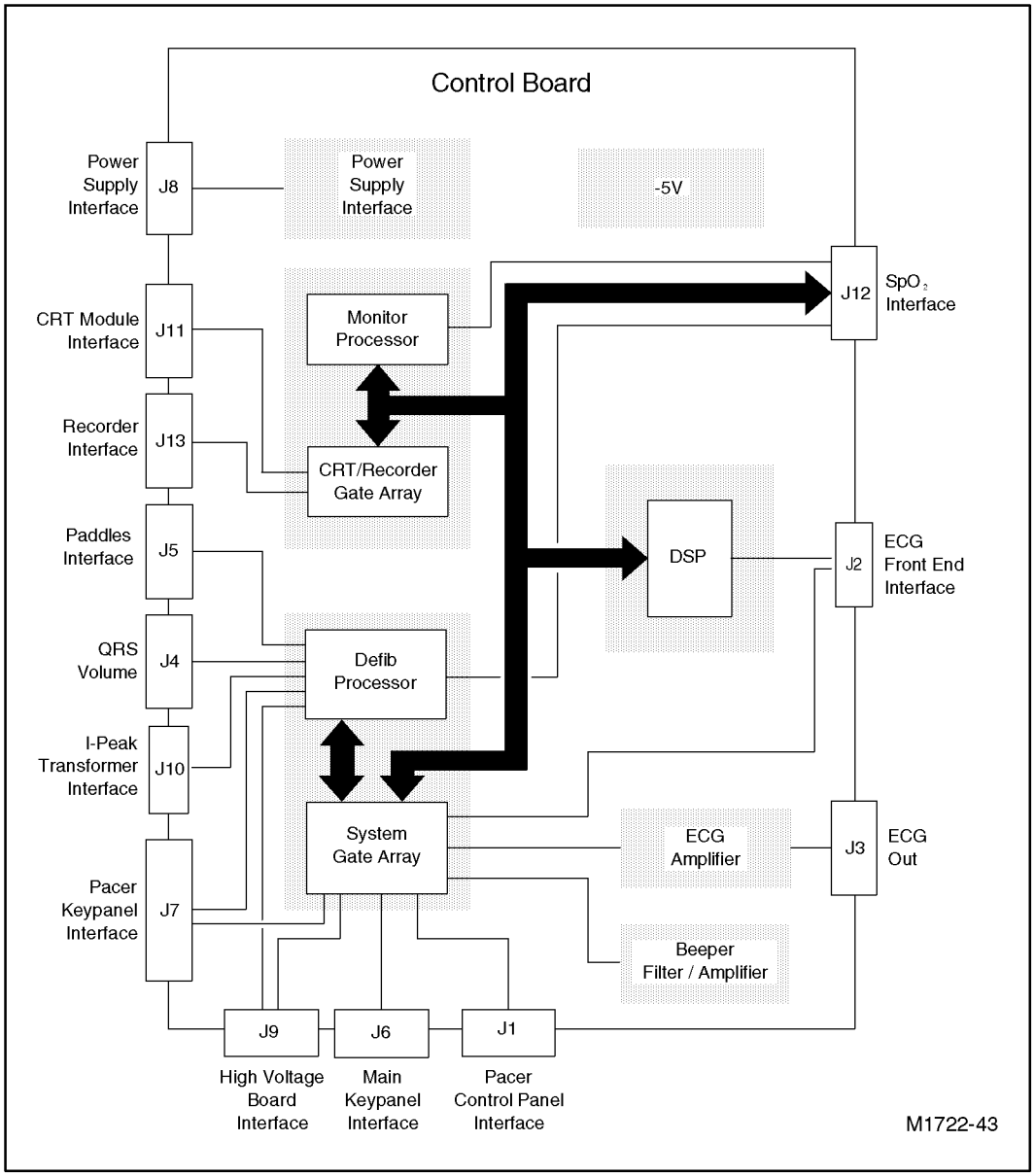
With a few exceptions, the only signal names used in this theory description are those that pass between the boards. Appendix A provides signal descriptions for each connector. Some signal names are prefixed with a letter that indicates what kind of signal it is. While this is not always true, you can usually assume the following:

c **Connector Signals. These have been conditioned for EMI purposes.**
f **Filtered Signals. These signals have been low-pass-filtered to minimize the high frequency components that they would otherwise contain.**
n **Active Low.**
p **Pulsed signals (except for clocks, which usually have ‘clk' embedded in their names).**

Control Board

The control board provides the processing power to run the defibrillator and supplies a central interconnect for other parts of the instrument. Three processors are supported on the control board: an 80960KA (the Monitor processor), a µPD77C25 (Digital Signal processor–DSP), and an 80C196KC (the Defibrillator processor). These processors are connected to one another and to peripheral devices through two CMOS gate arrays, the System gate array and the CRT/Recorder gate array. Figure 7-1 shows the functional groupings and their basic interconnections.

Figure 7-1



Control Board Block Diagram

The control board performs a variety of individual functions that fall into three major functional groups, each centered on one of the three processors. Other functions on the control board include the power supply interface and three analog functions.

Defibrillator Processor Functional Group

The Defibrillator processor handles the keyboard and indicator interface, system monitoring, and, with the System gate array, defibrillation control.

Defibrillation Control

Defibrillation control includes the charging and discharging operations.

Charging

The Defibrillator processor detects the closure of the paddles charge key, finback, at one of the processor's direct analog inputs, or it detects the closure of the front panel charge key, fnCHARGEKEY, by reading its value from the System gate array. After a debounce time, the key closure is considered valid and the processor begins a charge operation. The level of charge is determined from the value of four bits from a grey-coded rotary switch (fENSEL0, 1, 2, and 3) (also read from the System gate array).

Before charging begins, the Defibrillator processor instructs the System gate array to open the safety relay, which is located on the high voltage board. The System gate array asserts fOPNSFRLY (open safety relay), which commands the high voltage board to remove the 47 kΩ safety resistor that is normally across the High voltage capacitor.

A charge operation begins when the Defibrillator processor instructs the System gate array to assert the logic signal fnCHGEN and give the analog signal fCHRATE a non- zero value. These signals go to the high voltage board, which begins charging at the specified rate. While the charging proceeds, the Defibrillator processor monitors the energy present in the High voltage capacitor by sampling the capacitor voltage, fVCAP.

When the processor is satisfied that the proper energy is stored in the High voltage capacitor, it turns the charger off by placing a zero value on the fCHRATE line, and de-asserting fCHGEN. As charge bleeds off the High voltage capacitor, the processor will periodically request refresh charges from the charging circuitry. If the requested charge is lowered, the safety relay is used to bleed off charge to the lower level.

Discharging

A shock request occurs when both the Sternum and Apex Shock keys are closed, asserting fnDISCHGS and fnDISCHGA. These two signals are "NORed" to generate fHVDISCHG which is routed to both the Defibrillator processor and the high voltage board (for redundancy purposes).

The Defibrillator processor performs the shock operation by issuing a shock request command to the System gate array. When this happens, the System gate array takes over. It begins a waiting period (approximately 1 msec.) that allows the processors to prepare to be reset. When the waiting period is over, all processors are reset. The System gate array then asserts fPRDRV, which when combined with fHVDISCHG, closes the patient relay. Once the patient relay is closed, only fPRDRV true is required to keep it closed. The safety relay is also closed (fOPNSFRLY is de-asserted) when the fPRDRV line is asserted.

When the shock reset time is over (approximately 80 msec from shock initiation), the system gate array releases all processors from reset. All processors then perform post-shock initialization and resynchronize communication paths. At 300 msec from shock initiation, the defibrillator processor opens the patient relay, thus terminating the shock sequence

System Monitoring

The Defibrillator processor monitors a variety of system functions. Some of these are read directly by the processor at its analog inputs, while others are first preselected using an analog multiplexer. The direct measurements are:

Capacitor voltage	**A sample of the voltage across the High voltage capacitor (VCAP). Used to determine the energy stored in the capacitor. One volt at the A/D equals 1144 volts at the H.V. capacitor.**
QRS volume control	**Reads the value of fQRSCNTL to set the volume level of the QRS tone. fQRSCNTL varies between 0 and approximately 3 V depending on the setting of the QRS volume control.**
Printhead temperature	**Reads the value of fTSENSE, an analog signal generated by a temperature sensor on the recorder. Used to vary the duty cycle for printhead write in response to changes in printhead temperature.**
Head resistance	**The recorder board encodes printhead resistance into a voltage (fCAL). The Defibrillator processor converts fCAL to a digital signal used by the Monitor processor to set the duty cycle for printhead writes.**
Paddles identification	**The Defibrillator processor reads the voltage value on the fPADID line to determine the type of paddles connected to the instrument. Table 7-1 lists the voltage levels for the paddles types.**

Table 7-1 PADID Voltage Value vs. Paddles Type

fPADID	Paddles Type
< 0.5 V	Internal Paddles
≥0.5, < 3 V	External Paddles
≥3.0, < 4 V	External Pads
≥4.0 V	None

The multiplexed measurements are:

Peak current — **The Defibrillator processor reads the value on the SIPEAK line, which is a sample of the peak discharge current delivered to a patient. One volt at the A/D converter indicates 20.5 amperes of peak current.**

Pacer current — **The pacer current is sampled on the pacer board and delivered to the control board on the fPACMES line.**

Supply voltages — **The control board monitors the following voltages:**
- Battery (VBATT)
- +12 V (12V)
- +5 V (5V)
- +VDC (VDC2)

Defibrillator status — **The Defibrillator processor reads fDEFIBSTAT, an analog signal generated by the high voltage board to provide status information. Normally, the status is "good" when fDEFIBSTAT is >2.5 V, and "error" when ≤2.5 V. Immediately following a shock (while the patient relay is still closed) status is "good" when fDEFIBSTAT is <1.0 V, "error" when ≥1.0 V.**

Keyboard and Indicator Interface

The Defibrillator processor performs most of the keyboard and indicator functions through the System gate array. For keyboard functions, this is implemented with a parallel register set. The Defibrillator processor debounces keys, which are then saved in the System gate array. In the System gate array, both the Defibrillator and Monitor processors can access the debounced key registers.

Similarly, output drive for the LED indicators comes from a parallel port (controlled by the Defibrillator processor). These outputs drive emitter followers, which provide the current drive required by the LEDs.

All key lines are filtered for EMI. The filters also provide some protection to the inputs of the gate array.

The energy select switch is treated differently. It uses a 1 kΩ pull-up resistor to provide more current for switch contact reliability.

The Monitor Processor Functional Group

The Monitor processor (an 80960KA processor) handles central processing, and with the CRT/Recorder gate array, display control and recorder control. The Monitor processor also handles the interface with the Option Slot.

Central Processing

The main processing power of the system consists of the Monitor processor, its decoding and demultiplexing logic, ROM, and RAM. The CRT/Recorder gate array provides clocks and various control signals to these parts. The Monitor processor operates at 8 MHz (clk2 equals 16 MHz).

System ROM consists of two 64Kx16 or 128Kx16 devices which are socketed; system RAM consists of four 128Kx8 devices. System RAM and the RAM interface to the processor are backed up by battery to ensure that data is not lost during power-up or power-down. The real-time clock circuitry is also backed up by the battery.

The Monitor processor communicates with the Defibrillator processor and the real-time clock through the System gate array. The System gate array also provides four levels of Monitor processor interrupts.

Display Control

The CRT/Recorder gate array interfaces the Monitor processor to the display. The gate array generates the necessary strobes to support a fixed-plane 256Kx4 VRAM and a moving-plane 256Kx4 VRAM, and provides video and sync information for the CRT. Both full-bright and half-bright information is provided to the CRT. The gate array also allows the Monitor processor to randomly read and write VRAM.

Recorder Control

The CRT/Recorder Gate Array also interfaces the recorder to the Monitor processor. The recorder requires four 384-bit serial data streams every 5 ms. Because of the very high overhead that would be required for the processor to do this directly, the CRT/Recorder gate array converts this to 48 32-bit accesses (performed via DMA) from system RAM. The CRT/Recorder gate array also generates the appropriate motor control strobes to operate the recorder stepper motor. These motor control strobes are pulse-width modulated at 32 kHz to reduce motor current consumption.

To maximize printhead life and reliability, an electronic power switch turns off the supply voltage when the recorder is not in use. The power switch is an FET with very low on-resistance and is turned on or off by processor command.

Interface to the Option Slot

The Monitor processor interfaces to the option slot through J12. This interface consists of an 8-bit address/data bus with associated strobes for direction and timing control. The

option slot interface includes two reset lines, nERAWRST and nPRST, from the control board, and three interrupts from the option slot. Supply voltages available to the option slot are +5 and +12 from the main power supply, and +DIGBACKUP from the digital backup supply on the control board.

The optional SpO_2 board uses the option slot.

Digital Signal Processor

The uPD77C25 Digital Signal Processor (DSP) handles digital signal processing of ECG front end information. The DSP and its supporting logic interface to the ECG front end serially using the signals fFESI, fFESO, fnFESENL, and fnFESENP. The DSP interfaces to the Monitor processor through the CRT/Recorder gate array.

Power Supply Interface

The power supply interface consists of four parts:

• Digital backup supply

• Power failure detector

• Switch A control

• LED drivers

Digital Backup Supply

VDC2 and VBATT are diode-ORed to form +VBACKUP. +VBACKUP passes through a low current regulator to generate a 4.3 V supply, +DIGBACKUP. This provides a power source whether on battery only or AC only. +DIGBACKUP powers the On/Off circuitry and VRAM.

Power Failure Detector

When the +5 V supply voltage drops below +4.65 V, this circuit generates nPF, a signal that interrupts both processors via the System gate array, and ≈8 ms later produces nRAWRST, the basic reset signal.

Switch A Control

Switch A is a solid-state FET switch in the power supply that connects the battery to VDC. When the defibrillator is connected to AC, Switch A closes to allow VDC to charge the battery. When the defibrillator is not connected to AC and the instrument is turned on, Switch A closes to allow the battery to power the instrument. The Switch A control circuit generates fSWADRIVE, the drive signal for Switch A. fSWADRIVE closes Switch A under the following conditions:

- AC is present and the high voltage capacitor is not charging
- The defibrillator is on and the battery voltage is higher than the shutdown voltage (no AC)
- The battery is below the shutdown voltage but is charging the high voltage capacitor (no AC).

The Switch A control circuit includes part of the mechanism that shuts down the instrument when the battery gets too low. One minute after the Defibrillator processor detects that battery voltage has become too low, it instructs the System gate array to set a flip-flop in the Switch A control circuit. This turns off SWADRIVE to open Switch A and disconnect the battery. If the defibrillator is connected to AC, the instrument will continue to operate. If the defibrillator is not connected to AC, turning the energy select switch off and then on will restore operation for another one minute until the low battery condition again forces the instrument to shut down.

LED Drivers

One driver provides power to the battery charging LED when AC power is on and the battery is installed; the other driver provides power to the AC-on LED when AC power is on.

Miscellaneous Analog Functions

Miscellaneous analog functions performed on the control board are:

- I-peak measurement — A voltage winding in the Patient inductor samples discharge current. The I-peak measurement circuit integrates and peak-detects the sample to produce SIPEAK.
- –5 V generation — a voltage inverter converts +5 V to the low-current –5 V used by some of the operational amplifiers.
- ECG amplification — an AC-coupled voltage doubler that converts a CMOS-level pulse-width-modulated signal from the Defibrillator Gate Array into the 10 V peak-to-peak (+5 V to –5 V) signal required by the 1000:1 ECG output.
- Beeper filtering/amplification — filters and amplifies the TONE signal that comes from the System gate array. Provides a 12 V peak-to-peak signal to drive the beeper.

Power-Up/Down Processes

The following is a description of how the control board performs the powering-up and powering-down processes. It is assumed that the instrument is either plugged in to the AC mains or that a charged battery is installed. In either case, +VBACKUP is about +12 V and +DIGBACKUP is at +4.3 V.

OFF State

When the energy select switch is in the off position, the fnON signal line is pulled high. This tells the power supply to not generate any of its regulated voltages. Consequently, +5 V is near ground and the power-fail detector holds the power-fail signal (nPF) low and generates nRAWRST. nRAWRST is the reset signal that generates most of the other reset signals.

Power-Up

When the energy select switch is moved from its off position, fnON is shorted to ground. This tells the power supply to start generating its regulated voltages. When the 5V supply reaches +4.72V, nPF goes high. About 450 ms later, nRAWRST also goes high.

nRAWRST going high tells the gate arrays to begin generating clocks and to start their exit from reset processes. When all the resets are released, the Monitor processor performs its boot-up and tries to establish communications with the Defibrillator processor via the System gate array.

The Monitor processor does a self-check when it comes out of reset. When first released from reset, the Monitor processor drives the nFAILURE line low. It then performs a series of internal checks. If the results are satisfactory, it releases the nFAILURE line. The processor then fetches the first eight words from memory (ROM) and performs a checksum on the results of the fetch. If the checksum is correct, the processor continues. If not, the nFAILURE line is again driven low and the processor halts operation. By watching the nFAILURE line as the processor comes out of reset, you can determine whether the processor is functioning internally and whether its connection to ROM is functioning.

Power-Down

A power-down sequence is initiated by the power-failure detector. When the energy select switch is moved to its off position or +5 V supply drops below +4.65 V, the power-failure detector asserts nPF (the power fail signal). This signal is routed to the System gate array, which then drives a power- fail interrupt to both the Monitor and Defibrillator processors. These interrupts tell the processors that they have 1 ms of power to accomplish any tasks that must be performed before they shut down. 8 ms after nPF occurs, nRAWRST is asserted

Power Supply

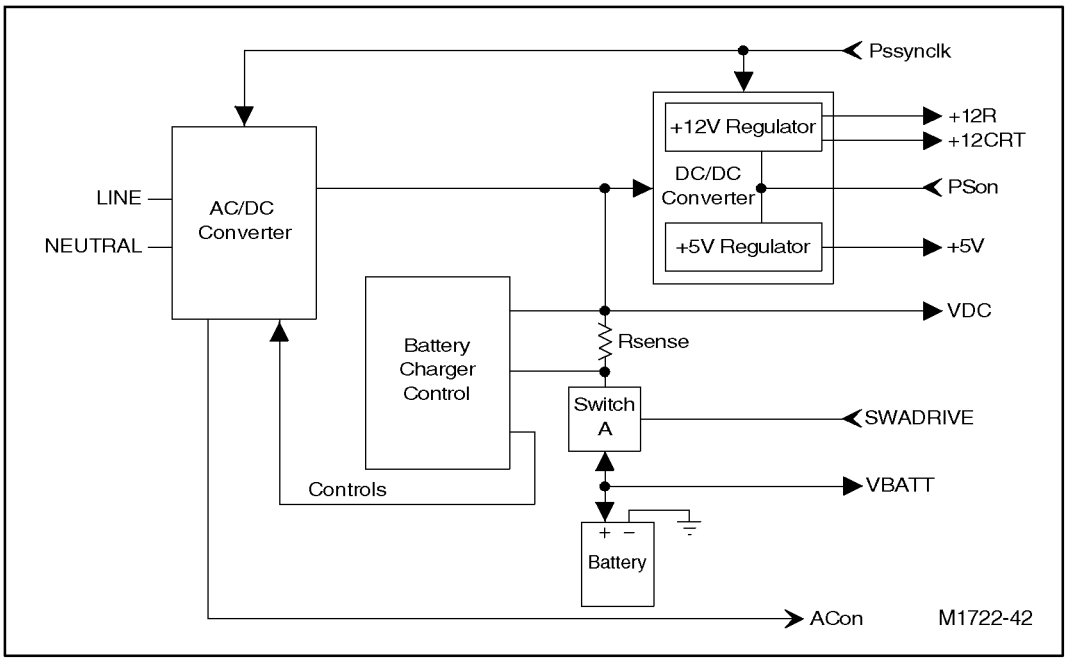
The power supply is a universal input supply that accepts 80 - 264 Vac input. It provides +5 and +12 volts to operate the defibrillator logic and display circuits, and approximately 13.5 volts (VDC) to charge the battery and power the high-voltage charger and recorder. The block diagram of the power supply is shown in Figure 7-2. This description of the power supply covers detail at the functional block level. The functional blocks that make up the power supply are:

• AC/DC Converter

• Battery Charger Control

• DC/DC Converter

Figure 7-2



Power Supply Block Diagram

AC/DC Converter

The first stage of the power supply is the AC/DC converter, a forward converter that supplies VDC (13.5 - 16.0 volts) to the DC/DC converter, the high voltage charger, and the battery (as the charging voltage).

Battery Charger Control

SWADRIVE (switch A drive) closes the FET switch between the battery and the AC/DC converter supplying VDC, when the instrument is powered by the battery only. When the instrument is turned on, switch A is closed to provide battery voltage to the DC/DC converters primary side.

Switch A is also closed when ACON is true (AC is on) and the instrument is off, in order to charge the battery. Rsense is a bank of resistors used to sense the amount of current being delivered to the battery when it is being charged. When the battery supplies the system, however, Rsense is bypassed in the battery charger control circuitry. The battery charger is a three state charger and is temperature compensated. The following list details the three states.

1 Current limit; charges the battery at 1.60 A rate until charge voltage reaches the over-charge voltage.

2 Over charge; charges at a voltage greater than Vfloat (nominal charge voltage), V-overcharge ≈ 14.5 V @ 25°C).

3 Float voltage; charges the battery at Vfloat (13.6 V @ 25°C) when charging current is less than 120 mA.

DC/DC Converter

When the instrument is turned on, the DC/DC converter provides +12 and +5 output voltages from an input voltage range of 9.0 Volts (lowest battery voltage under Defibrillator charge) to 16.0 volts (highest VDC) using a flyback converter. The DC/DC converter is powered by the AC/DC Converter at all times unless operating on battery only.

Efficiency of the DC/DC converter is specified at 80% and is optimized for greatest efficiency at nominal load.

High Voltage Board

The following circuits make up the high voltage board:

• Battery connector

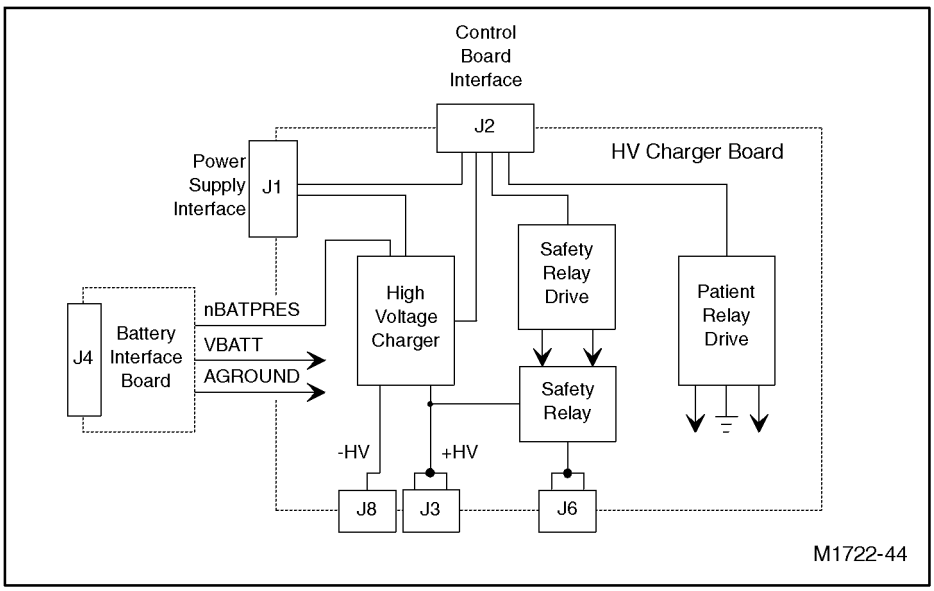
• Safety relay drive

• Patient relay drive

• High voltage charger

These circuits are shown in Figure 7-3.

Figure 7-3



High Voltage Board Block Diagram

Battery Connector

The Battery Connector board is a small circuit board that connects the lead acid battery to the defibrillator. Fuse F1 (located on the Battery Connector board) protects the battery from inadvertent instrument shorts. Power is routed to the high voltage board via cable assemblies P3 and P4. Battery voltage is then routed through the high voltage board to the power supply via connector J1.

Safety Relay Drive

The safety relay is normally closed and opens when control signal OPNSFRLY is true. As described earlier, this relay must open before the high voltage capacitor can charge. When a defibrillation discharge occurs, the safety relay closes simultaneously with or up to 10 ms before the patient relay closes. The safety relay circuit will then disarm the capacitor on an open paddles discharge.

Patient Relay Drive

The patient relay switches high voltage to allow a defibrillator shock. For this to occur, both shock switches must be pressed to assert the signal DISCHRG, *and* the Defibrillator processor must issue the shock command PRDRV (patient relay drive), which activates the patient relay. The Defibrillator processor monitors the status of the discharge control circuitry by reading fDEFIBSTAT. The Defibrillator processor can then display the appropriate error message in case of a fault. Error messages are explained in Chapter 4, Troubleshooting.

High Voltage Charger

The high voltage charging circuit charges the High voltage capacitor by means of a variable frequency, high-voltage flyback DC/DC converter. When the charging circuit is at room temperature and powered by a fully charged battery, ‘fast charge' occurs. In this mode the defibrillator can charge to 360 joules in under five seconds. When at room temperature but powered by AC only (battery not installed), ‘normal charge' occurs. In this condition the instrument will charge to 360 joules in less than 15 seconds. The charging of the High voltage capacitor is electrically isolated from grounded portions of the instrument.

A charge begins when the signals OPNSFRLY, nCHGEN, *and* CHRATE are asserted. When the High voltage capacitor reaches the proper energy setting, the Defibrillator processor de-asserts the signals nCHGEN, and CHRATE to stop the charge.

Patient Circuit

The patient circuit (shown in Figure 7-4) consists of the following components:

• High voltage capacitor (35 µF, 5.1 kV)

• Patient inductor/Ipeak Transformer (50 mH, 11 Ω)

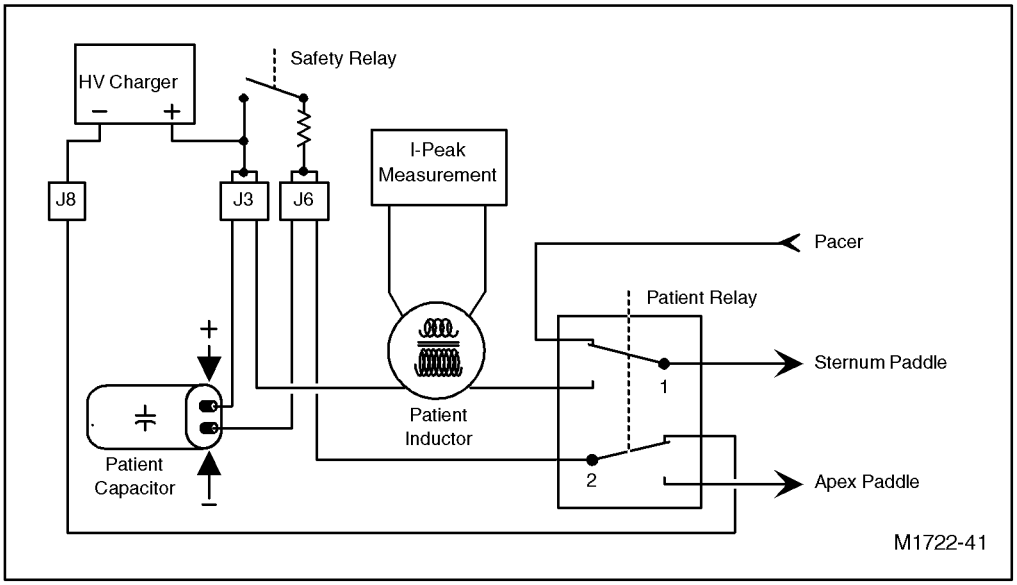
• Patient Relay (Double-pole, Double-throw Mechanical Relay)

• Coil Cords, Connectors, and Discharge Paddles

• Safety Relay (Single-pole, Single-throw Mechanical Relay)

• Patient Load (either a patient or the internal 50 Ω test load resistor)

Figure 7-4



Patient Circuit Block Diagram

The High voltage capacitor, Patient inductor, and patient load form a series-resonant LC circuit with a critical damping load resistance of 63 Ω. For a nominal patient load of 50 Ω, the discharge waveform is a slightly underdamped sinusoidal waveform.

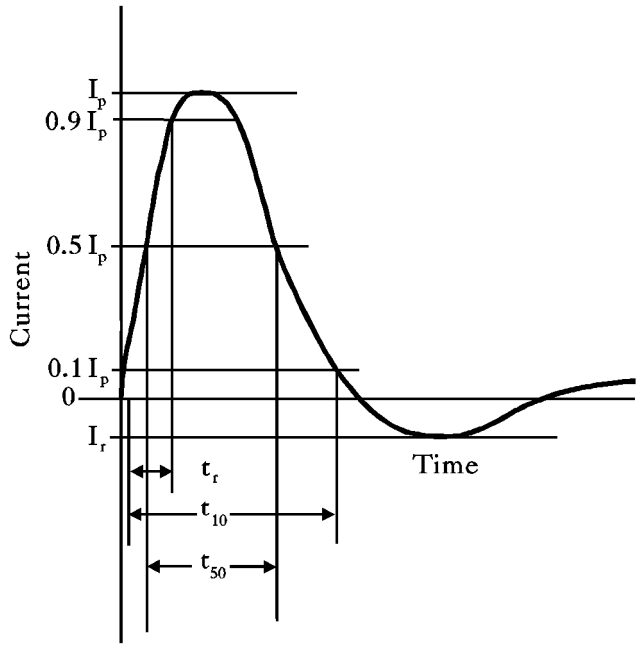
The High voltage capacitor is charged up by the High Voltage Charger to the voltage required for any of the various energy settings, which range from 2 to 360 Joules (actual voltage on the High voltage capacitor ranges from 325 V and 5300 V). This capacitor is then discharged through the Patient inductor and the patient relay into the patient load.

During a shock, the patient relay isolates the patient circuit and capacitor from one side of the pacer circuit to prevent the pacer from absorbing energy from the delivered pulse, and isolates the high voltage charger from the capacitor to protect the charger from reverse polarity during waveform undershoot. The waveform characteristics of the pulse delivered through resistive loads of 25, 50 and 100 ohms is shown in Figure 7-5 and Table 7-2.

The Patient inductor has a secondary winding that develops a voltage during discharge. This voltage is integrated and peak-detected on the high voltage board to determine the peak discharge current, Ipeak. The coil cords carry the discharge current to the paddles and patient load, and also carry control signals to and from the paddles. The coil cords contain shielding to lower the RFI sensitivity of the high voltage discharge wires so they can also be used as low-noise sensing wires for the paddles ECG circuit on the ECG front end board.

The Safety relay is in series with a 47 kΩ resistor and both are located on the high voltage board. This circuit slowly discharges the capacitor when its energy is not needed but still present (i.e. aborted shock). This circuit also bleeds off part of the charge if the user selects an energy setting, the defibrillator charges to that setting, and then the user selects a lower energy setting.

Figure 7-5



Damped Sinusoidal Waveform Parameters

Table 7-2 **Specifications for Damped Sinusoidal Output Waveforms**

	Local Resistance		
Waveform Parameter	**25 Ohms**	**50 Ohms**	**100 Ohms**
I_p (amperes)	$96\alpha \geq I_p \geq 55\alpha$	$66\alpha \geq I_p \geq 45\alpha$	$46\alpha \geq I_p \geq 25\alpha$
I_r (amperes)	$38\alpha \geq \lvert I_r \rvert \geq 0.0$	$18\alpha \geq \lvert I_r \rvert \geq 0.0$	$4.0\alpha \geq \lvert I_r \rvert \geq 0.0$
t_r (ms)	$1.60 \geq t_r \geq 0.50$	$1.42 \geq t_r \geq 0.40$	$1.25 \geq t_r \geq 0.30$
t_{50} (ms)	$4.60 \geq t_{50} \geq 2.0$	$4.17 \geq t_{50} \geq 2.10$	$6.40 \geq t_{50} \geq 2.30$
t_{10} (ms)	$6.90 \geq t_{10} \geq 3.0$	$9.20 \geq t_{10} \geq 3.10$	$19.60 \geq t_{10} \geq 4.00$

I_p **Peak current of the waveform**

$|I_r|$ **Absolute value of the reverse current of the waveform**

α $\frac{E}{360}$ **and E is the selected energy that would be delivered to a 50-ohm resistive load**

t_r **10% to 90% risetime of the first lobe of the current waveform**

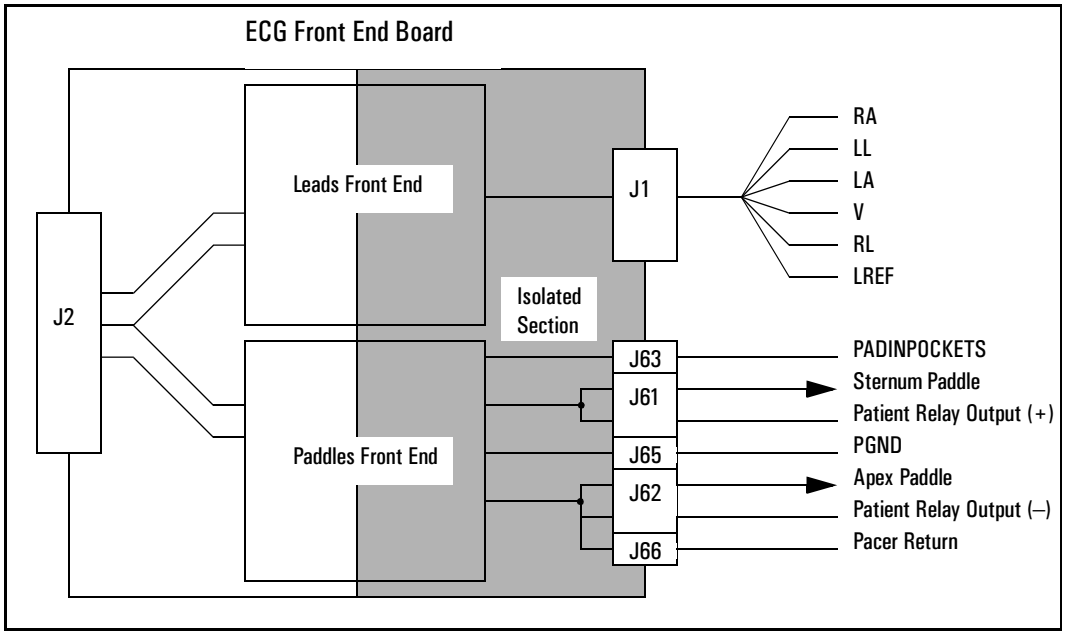
t_{50} **Waveform width associated with the 50 percentage points of the first lobe of the current waveform**

t_{10} **Waveform width associated with the 10 percentage points of the first lobe of the current waveform**

ECG Front End Board

Two separate and isolated front ends constitute the ECG front end board as shown in the block diagram in Figure 7-6. The first is a two-wire paddles ECG amplifier, and the second is a five-wire leads front end. The paddles front end operation is nearly identical to the leads front end operation. The design for both front ends is based on a Hewlett-Packard custom front-end IC. The paddles front end also includes functions for paddles-in-pocket and pre-shock impedance (also called paddles contact impedance or PCI).

Figure 7-6



ECG Front End Block Diagram

Both front ends communicate with the Digital Signal Processor (DSP) located on the control board. The DSP processes the digitized data from both front ends simultaneously and provides data to the monitor processor.

Power Supplies

Each of the front ends has its own isolated power supply. The supply for the leads front end is enabled when the FELEN signal is true; the supply for the paddles front end is enabled when the FEPEN signal is true. A forward converter, which is clocked by FEPWRCLK, generates isolated power for the two front ends. The output of the converter is regulated to +5 volts. The supply also provides a 2.5-volt reference for use in biasing the front end IC.

Leads Input Protection

The leads are connected to the five input channels of the IC through a breakdown device (neon bulb) and a 2-pole LPF. The neon bulb is used as Defibrillator overload protection (current is limited by a 1 kΩ resistor in the lead set). The remaining voltage is dropped across 75 kΩ and the internal protection diodes of the IC.

Paddles Input Protection

The paddles inputs are subjected to defibrillator shocks, and therefore are designed to meet 8 kV breakdown from paddle-to-paddle. 100 kΩ high-voltage resistors in series with the ECG input limit the current sufficiently to allow the input protection diodes on the front end IC to handle the current. As part of the pre- shock impedance path, series resistors and capacitors are also high voltage devices. External diode clamps are added to this path, routing current away from the front end IC.

Cal Pulse

Internally generated signals allow for self-test and gain calibration.
A 1mV 200ms calibration pulse can be printed on the ECG strip by pressing both arrows on the (▼ECG Size▲) key simulaneously.

Data Communication

Clocks and data are transmitted through opto-isolators across the isolation boundary. Data transmitted to the front end IC include control parameters such as gain, Right Leg Drive lead, etc. Digitized ECG data and status information is transmitted from the front end IC to the DSP chip on the control board.

Pre-Discharge Impedance

An indication of paddles contact is given on the bar graph located on the external paddles (PCI). Patient impedance (at 32 kHz) is measured by the paddles front end IC. This measured impedance value is used by the Defibrillator processor to determine the drive level to the PCI bar graph on the sternum paddle.

Paddles in Pocket

To detect paddles in pocket, the paddles front end IC applies a signal to the center tap of the 50 Ω test load resistor (the center-tap is connected to the paddles front end through connector J63). If this signal is detected on the Vapex and Vsternum inputs, the front end IC signals that the paddles are in the pockets.

CRT Deflection Board

The CRT deflection board (shown in Figure 7-7) performs these functions:

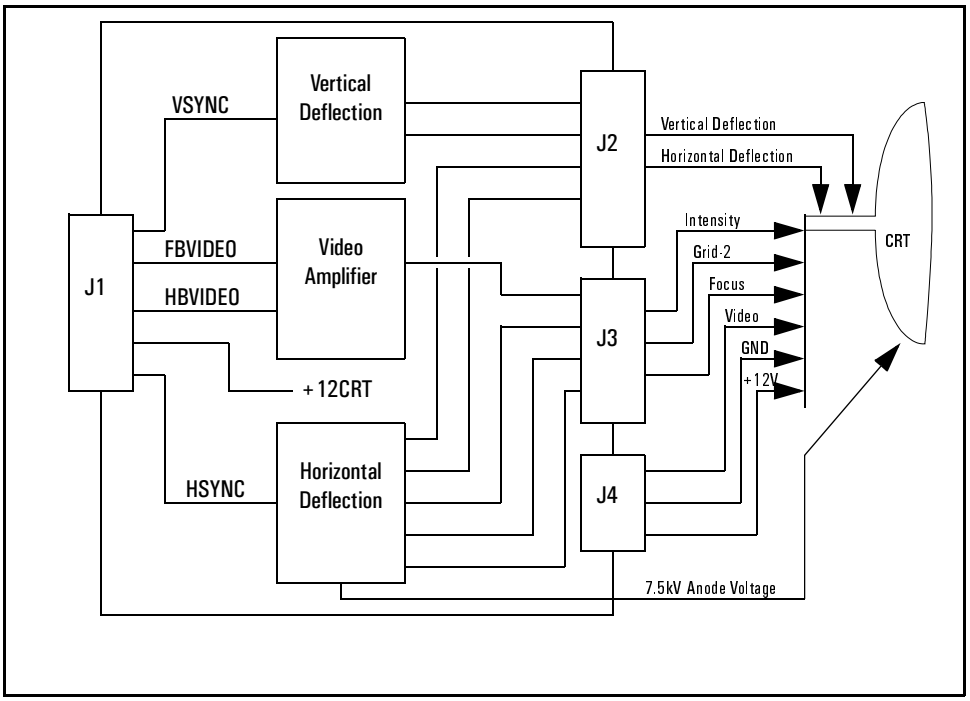
• Vertical deflection

• Horizontal deflection

• Video amplification

• CRT bias voltage generation

Figure 7-7



CRT Assembly Block Diagram

Signals entering the CRT deflection board from the control board are GND, VSYNC, VIDEO, CRT12V, and HSYNC.

The CRT displays information using a raster pattern. Total usable raster area is 832 dots horizontal, 256 dots vertical. Table 7-3 lists the specifications for the CRT.

Table 7-3 CRT Specifications

Characteristic	Specification
Screen Size	140 mm Diagonal
Deflection Method	Magnetic
Deflection Angles	Diagonal - 70 degrees
	Horizontal - 66 degrees
	Vertical - 45 degrees
Phosphor	P43 (Yellow-Green)
Heater	75 mA, 12 V (typical)

Control signals to drive the CRT come from the CRT/Recorder gate array on the control board. Table 7-4 lists the control signal specifications:

Table 7-4 Control Signal Specifications

Vertical Deflection	
Frequency	57.1 Hz
Period	17.5 ms
Blanking Time	1.5 ms
Vertical Sync	750 us (Active High)
Horizontal Deflection	
Frequency	16.0 kHz
Period	62.5 us
Blanking Time	11.7 us
Horizontal Sync	11.7 us (Active Low)
Video	
Dot Time	61 ns (Active Low)

Vertical Deflection

Vertical deflection is accomplished by running a linear current ramp through the vertical coil on the CRT yoke. The Vertical Sync (VS) signal from the CRT controller generates the vertical deflection for the CRT.

Horizontal Deflection

The Horizontal Sync (HS) and CRT bias voltages are generated when HS drives the flyback transformer, which provides supply voltages and horizontal deflection. Horizontal centering must be accomplished using the external magnets on the CRT yoke assembly. Horizontal width is adjusted with a series inductor, also built into the yoke assembly.

The following supply voltages are created for use in biasing the CRT:

+28 V	**Video amplifier and Vertical retrace**
-39 V	**Intensity (adjustable)**
300 V	**Grid 2 bias**
300 V	**Focus (adjustable)**
7.5 kV	**Anode Voltage**

Video

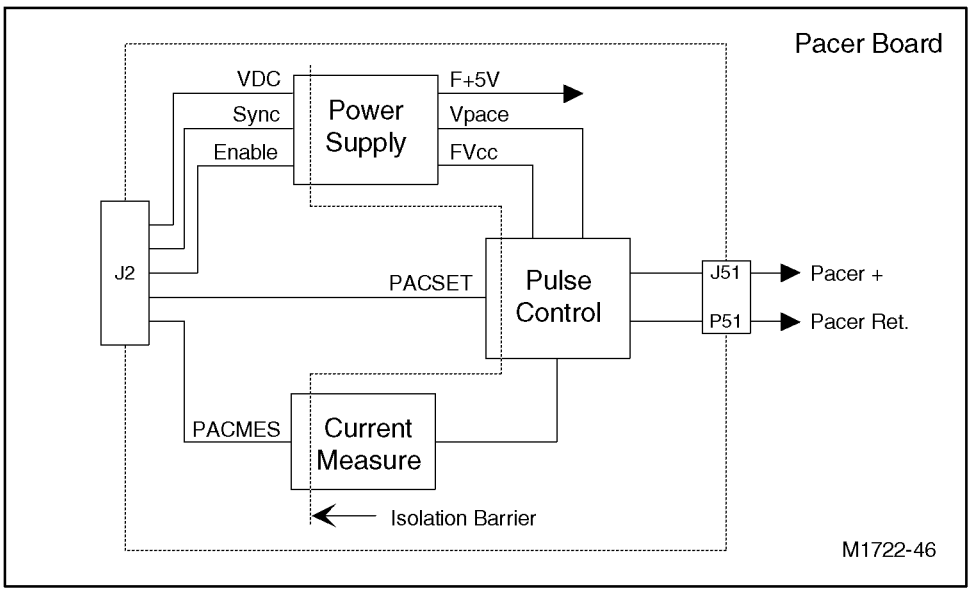
Two levels of video are presented to the CRT: full-bright and half-bright. Half- bright video is used for text, while full-bright video is used for ECG data. The beam is at full brightness when the video output to the CRT is 0 V, at half brightness when the video output is 4.3 V, and off when the video output is 28 V.

Pacer Board

The pacer consists of the circuits shown in Figure 7-8. The pacer board generates pacer output to these specifications

Current Pulse	**20 ms +0% -25%**
Amplitude	**10 mA to 200 mA, 10 mA to 50 mA: ±5 mA,**
	50 mA to 200 mA: ±10%
Rate	**40 to 180 pulses-per-minute ±1% at each setting**

Figure 7-8



Pacer Block Diagram

Power Supply

An isolated supply on the pacer board generates 5 and 12 V power (F+5V and FVcc, respectively) to run the pacer electronics, and the 120 V pacer voltage (Vpace).

Pulse Control

Pace pulse amplitude is set by a pulse width modulated signal from the System gate array. The duty cycle for the PWM signal is 13.5% to 90%, corresponding to a pulse amplitude from 10 mA to 200 mA respectively.

The pulse train from the System gate array is 20 ms long. When the pulse train starts, it begins the current pulse. When the pulse train ends, the current pulse will end.

Pacer Current

Pacer current is measured and routed back to an A/D converter (internal to the Defibrillator processor). Then, delivered pacer current can be compared to the expected set current.

Patient Isolation

The pacer is a patient connected device, therefore adequate patient isolation must exist for pacer circuitry. A high voltage isolation barrier is formed by a power transformer in the power supply, and opto-couplers in the pulse control and current measuring circuits.

SpO_2 Board

The arterial oxygen saturation measurement (SpO_2) is based upon the principle of pulse oximetry, whereby arterial blood flow is detected optically though the tissue. As the blood becomes more heavily oxygenated the transmittance of red light increases. An algorithm comparing the transmittance of red and infra-red light provides an indication of oxygen saturation. The pulse oximeter circuit design eliminates the effects of absorption from tissue, bone, and venous blood by isolating the pulsatile component of the signal.

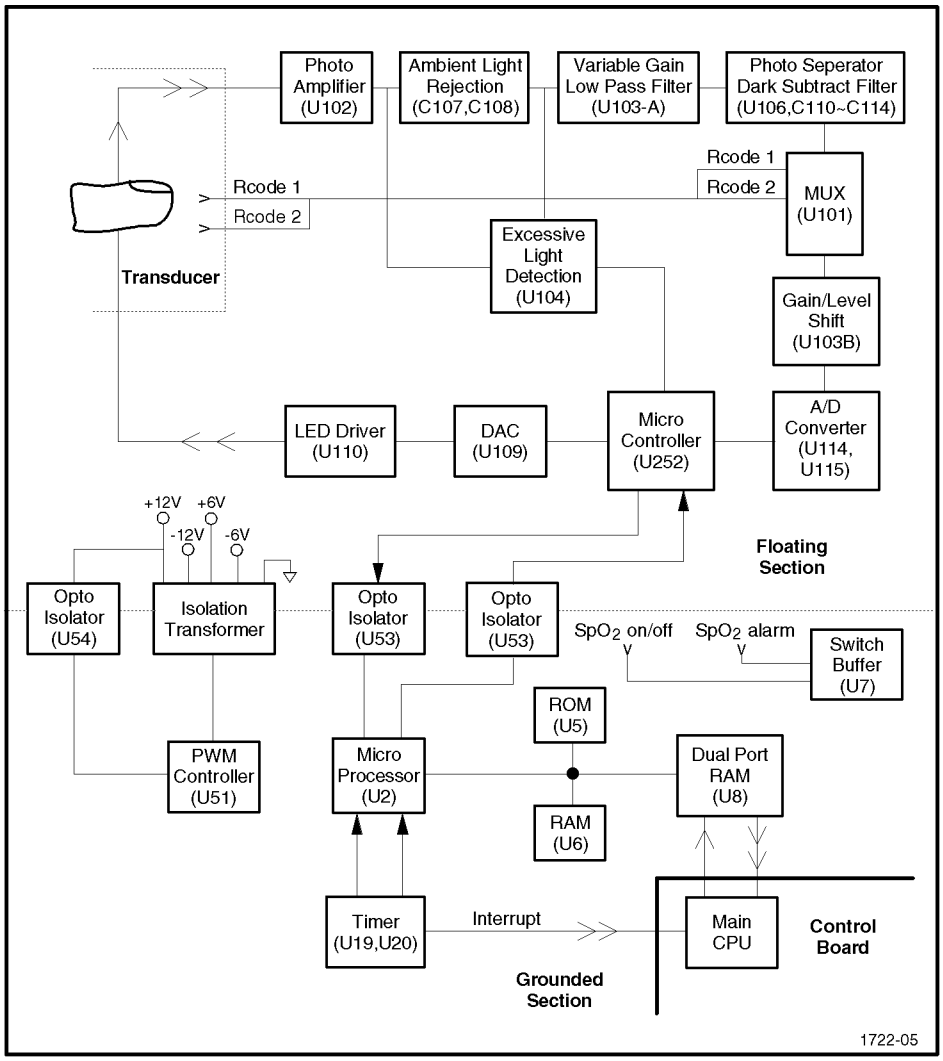
To measure the SpO_2 level an adaptor is placed on the patient. The adaptor holds two LEDs. The LEDs emit red and infra-red light against one side of the patient's finger (the nose or toe are other sites sometimes used). The adaptor holds a photo diode along the opposite side of the patient's finger. The photo diode is able to register small changes in the transmittance of light through the finger. The adaptor containing the LEDs and the photo diode is referred to as the SpO_2 sensor. The sensor is connected to the device via a cable and a connector.

The output from the sensor goes directly to the pulse oximeter parameter board (SpO_2 board). The SpO_2 board is located next to the CodeMaster CRT and is connected to the main CodeMaster control board via the option connector slot.

The SpO_2 board is divided into two distinct circuits - electrically floating and electrically grounded. These circuits are connected by two high voltage optocouplers for data transfer, and a power transformer for power transfer to the floating circuit.

The hardware design is summarized in the block diagram in Figure 7-9.

Figure 7-9



SpO_2 Board Block Diagram

Floating Section

The function of the floating section is two fold. First, the floating section enables accurate reading of light transmittance by removing noise and compensating for ambient light in the pulse train. Second, the floating section drives the red and infra-red LEDs in the transducer cable.

The LEDs are driven and the photo diode signal is sampled in four discrete phases:

1 Dark phase - During this phase neither red nor infra-red LEDs are lit and ambient light is measured.

2 Red phase - In the red phase the red LED is lit and the transmittance of the light through the finger is measured.

3 Infra-red phase - In the infra-red phase the infra-red LED is lit, and transmittance measured.

4 Pleth Phase - During this phase the infra-red LED is lit, and transmittance measured. This signal is used to drive the pulse indicator bar on the CodeMaster display.

Consecutive frames of these four phases are repeated 375 times per second. Both the lighting of the LEDs and the sampling of the signal from the photo diode is controlled by the microcontroller (U252).

Photo Amplifier

The photo amplifier (U102) converts current (output from the photo diode) to voltage. Low pass filtering for electrosurgical unit (ESU) filtering and noise reduction is also done in this stage.

Excessive Light Detection

A comparator (U104) monitors the output of the photo amplifier, checking for excessive light. Excessive light could cause amplifiers to operate in a non-linear range, giving erroneous readings.

Ambient Light Rejection

A two-pole high pass filter (C107, C108) rejects signals from ambient light.

Amplification

The op amp, U103A, is used as a variable gain amplifier. It amplifies the detected light signal to an optimal amplitude for the A/D converter. U103B applies additional gain and level shifting, centering the signal for the A/D converter.

Phase Separation - Dark Subtract Filter

A series of switched low pass filters (U106, C110 - C114) are used to separate the four phases of light (dark, red, infra-red, and pleth). The sequence of operation is software controlled. The four phase sequence is described as follows:

1 ***Dark phase*** The switch governing the dark capacitor (C110, C111) is closed. Switches governing the red, infra-red, and pleth capacitors (C112, C113, and C114 respectively)

are open. The dark capacitor is charged by the pulse resulting from the ambient light reading.

2 ***Red phase*** The switch governing the "Red" capacitor is closed. All other switches are open. Capacitor "Red" is charged by the pulse resulting from the red LED reading. The pulse received by amplifier U103B is equivalent to the value of (ambient light + red light) minus (ambient light).

3 ***Infra-red phase*** As (2) above, but using the "Infra-Red" capacitor.

4 ***Pleth phase*** As (3) above.

Multiplexer

A multiplexer (U101) is used to switch signals into the A/D converter. The signals are:

1 Received light signal.

2 Rcode1.

3 Rcode2.

Rcode1 and Rcode2 are resistors in the transducer. The voltage across these resistors is measured to determine that the transducer is properly connected, and the type of transducer connected.

A/D Converter

A sixteen bit successive approximation A/D converter is formed from a 16 bit DAC (U114), a comparator (U115), and a uP controller (U252).

LED Drivers

The LEDs are driven by a controlled current source (U110). The two functions provided by the LED driver are:

1 The LEDs must be lit in their correct sequence, to produce the four phases of the pulse frame.

2 The LEDs must be lit to an intensity that optimizes the signal to noise ratio of the received light signal.

An 8 bit DAC (U109) controls the LED driver (U110), using positive and negative pulses of 0 - 125mA, which trigger the red and infra-red LEDs respectively. The intensity of illumination is determined by the current of this triggering pulse.

Grounded Section

The grounded section of the SpO_2 board is completely digital. It is essentially a dedicated microcomputer, and among other tasks, performs the following:

1 Communicates with the floating section through the two opto-isolators.

2 Calculation of the SpO_2 saturation percentage and pulse rate.

3 Processes any error conditions (cable off, light interference, etc.)

4 Communicates with the main CPU board in CodeMaster via the option slot on the control board.

Dedicated timer circuits control the timing of events. In addition, the signals from the front panel keys SpO_2 ON and SpO_2 ALARM are routed through the SpO_2 board to the Control board.

Microprocessor System

The processor is a Hitachi 6303, using external RAM and ROM. The processor runs on a 2mS cycle, which is controlled by the timer circuits (U19 and U20). Once every 20mS the processor writes data to the Dual Port Ram (U8).

Communication

An interrupt is generated every 20mS, indicating to the Control that board data is available to be read. At this time, the switch buffer (U7) is read to check for any key presses, and SpO_2 data (SpO_2%, PR, error conditions) are read from the dual port RAM.

Power Supply

The power supply is designed to provide isolated power to the floating circuitry. The circuit is a fly back topology, with feedback though an opto isolator (U54) to control the pulse with modulator. The transformer includes taps to generate ±12V and ±6V. In addition, linear regulators exist on the floating side to generate +5V and -5.2V.

Patient Isolation

To ensure the safety of the patient the applied part is isolated from ground by optocouplers and a transformer. In addition, a mylar shield is used to isolate the floating circuitry from the CRT frame.

Recorder Interface Board

The Recorder Interface board provides power and control signals from the CRT/Recorder gate array to the printhead and motor.

The printhead control signals pass through the board to the printhead. These signals provide the data, clock (4 MHz), latch, and strobe for the printhead. Other signals provide status of the printhead to the gate array such as printhead temperature and resistance, which are required for print quality. An optical sensor in the recorder provides the status of the recorder door and recorder paper (if the door is open or the paper is out the `CHECK RECORDER` message appears on the monitor).

Keypanel Boards

The main keypanel board and the pacer keypanel board contain the push-button switches and LED indicators that provide the hardware user interface. The Energy Select switch connects to the main keypanel board.

Defibrillator-Pacer Patient Connections

The defibrillator provides support for the following methods of delivering defibrillation or pacing energies to the patient:

• Standard External Paddles

• Internal Paddles

• External Adhesive Pads

Standard External Paddles

The Standard External Paddle Set combines Adult and Pediatric defibrillation electrode surfaces in one paddle design. The Sternum paddle has a Paddle Contact Indicator (PCI, standard on the XL+, optional on the XL), and a Shock button. The Apex paddle has the CHARGE INITIATION button, a CHARGE DONE LED, and a Shock button.

The defibrillator determines paddle type by measuring the voltage on the CHDONE control line. The voltage range for a valid External Paddle Set is 0.5 - 3.0 volts. The Shock switches pull their respective lines (nDischarge Sternum, nDischarge Apex) to logic ground when pressed. Single fault tolerance is maintained throughout the discharge control path for operator safety. The Charge switch pulls the nCharge line low when pressed.

Internal Paddles

The Internal Paddles are connected to the defibrillator using a connector on the internal paddles adaptor cable. There are no shock control switches on the Internal Paddles themselves. The defibrillator is discharged by pressing two shock buttons located on the defibrillator connector housing.

The defibrillator determines paddle type by measuring the voltage on the CHDONE control line. The voltage for a valid Internal Paddle Set is less than 0.5 Volts.

External Adhesive Pads

The External Adhesive Pads are connected to the defibrillator using an auxiliary connector on the pads adaptor cable. External Pacing and Defibrillation can be performed through this connection. The defibrillator is discharged by pressing two shock buttons located on the defibrillator connector housing.

The defibrillator determines paddle type by measuring the voltage on the CHDONE control line. The voltage range for a valid external adhesive Pads adaptor is 3.0 - 4.0 V.

Appendix A Connector Pin Assignments

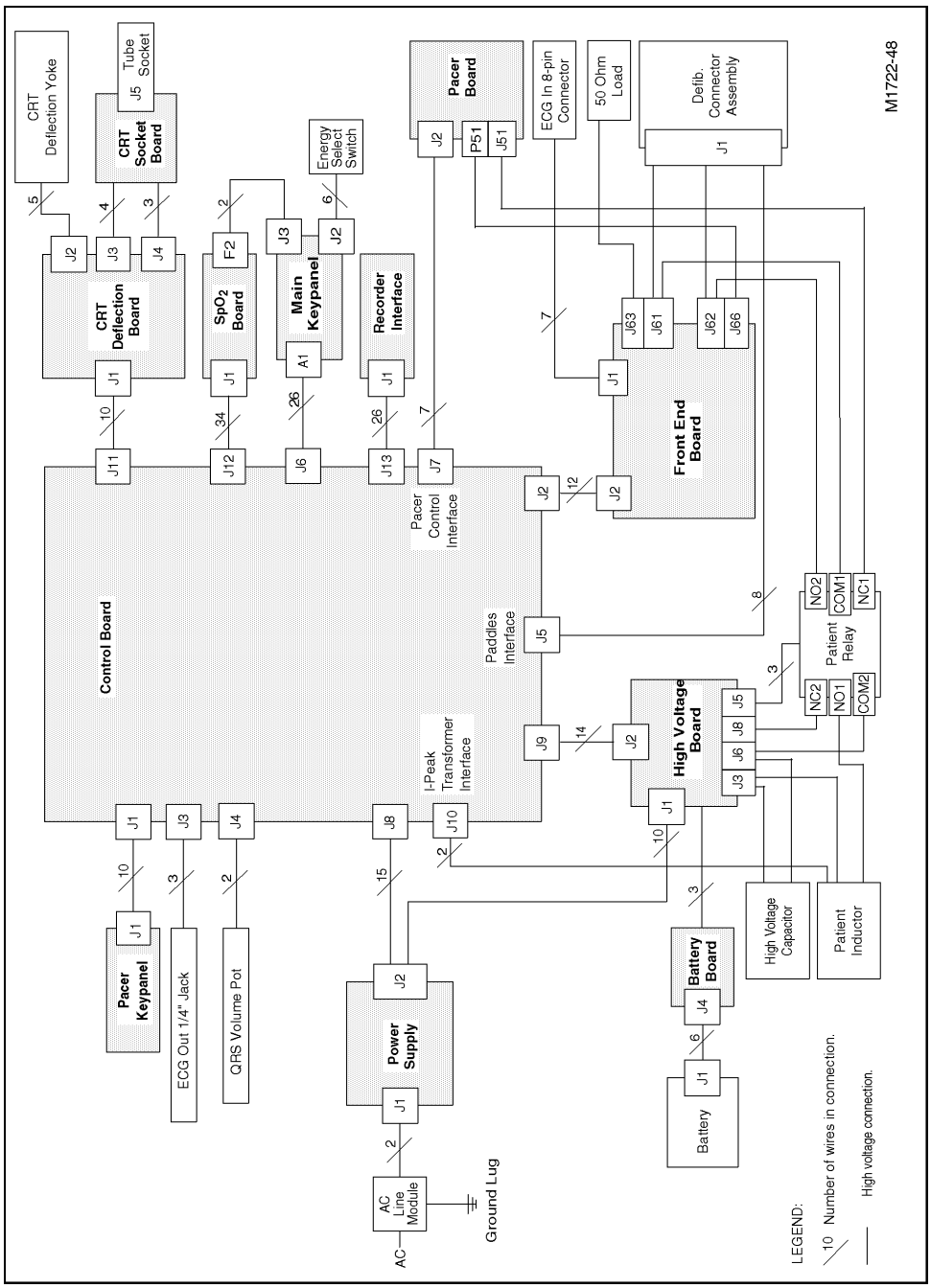
The tables in this appendix list the pin assignments for each connector on assemblies in the instrument. Following each table is a dictionary of the signal names listed in the table. Some signal names begin with a letter that indicates the signal type:

c	Connector signals. These have been conditioned for EMI purposes.
f	Filtered signals. These signals have been low-pass filtered to minimize the high frequency components that they would otherwise contain.
n	Active low signal.
p	Pulsed signals (except clock signals, which usually have ‘clk' embedded in their names.)

Refer to Figure H-1 to see how the assemblies interconnect. Pin assignments are given for these assemblies:

- Control board
- Front end board
- ECG Out connector
- QRS volume control
- Defibrillator connector
- Keypanel board
- Pacer keypanel board
- Pacer board
- Power supply board
- High voltage board
- Patient inductor
- CRT deflection board
- SpO_2 board
- Recorder interface board
- Battery board
- Battery
- HV capacitor
- Patient relay
- 50-ohm load
- ECG In connector
- AC line module
- Energy Select switch
- Beeper

Figure H-1



Interconnect Block Diagram

Control Board Connectors

Refer to Figure H-1 for the control board connector locations. Connectors on the control board are listed in Table H-1.

Table H-1 Control Board Connections

Control Board	Via Cable Assembly	Connects To	Reference
J1	M1722-61605	Pacer keypanel board	Table H-2
J2	M1722-61611	Front end board	Table H-3
J3	M1722-61624	ECG Out connector	Table H-4
J4	M1722-61910	QRS volume control	Table H-5
J5	p/o M1722-61626	Defibrillator connector	Table H-6
J6	M1722-60195	Keypanel board	Table H-7
J7	M1722-61617	Pacer board	Table H-8
J8	M1722-61606	Power supply board	Table H-9
J9	M1722-61610	High voltage board	Table H-10
J10	p/o M1722-82800	Patient inductor	Table H-11
J11	M1722-61619	CRT deflection board	Table H-12
J12	M1722-61628	SpO_2 board	Table H-13
J13	M1722-61618	Recorder interface board	Table H-14
J14	M1722-61632	Beeper	

Table H-2 Control Board J1 to Pacer Keypanel Board J1

Pin	Signal
1	GROUND
2	nPONOFF
3	PACONLED
4	nPMODE
5	nPACPRES
6	nPRATEINC
7	nPRATEDEC

Table H-2 **Control Board J1 to Pacer Keypanel Board J1**

Pin	Signal
8	nPCURINC
9	nPCURDEC
10	nPSTSTOP

NOTE

Each pin on the control board J1 connects to a pin with the same number on the pacer keypanel board J1.

Signal	Definition
nPONOFF	Pacer On/Off.
PACONLED	Pacer On LED. Drives the (Pacer On) LED on the pacer keypanel. The LED is on when the pacer function is turned on.
nPMODE	Pacer Mode.
nPACPRES	Pacer Present.
nPRATEINC	Pacer Rate Increase.
nPRATEDEC	Pacer Rate Decrease.
nPCURINC	Pacer Current Increase.
nPCURDEC	Pacer Current Decrease.
nPSTSTOP	Pacer Start Stop.

Table H-3 **Control Board J2 to Front End Board J2**

Pin	Signal
1	CGND
2	nFESENP
3	nFESENL
4	FESI
5	FESO
6	FEPEN
7	FELEN

Table H-3 **Control Board J2 to Front End Board J2**

Pin	Signal
8	FESCLKI
9	GND
10	FECHPCLK
11	FE5V
12	FEPWRCLK

NOTE

Each pin on the control board J2 connects to a pin with the same number on the front end board J2.

Signal	Definition
nFESENP	ECG Front End Serial Enable Paddles.
nFESENL	ECG Front End Serial Enable Leads.
FESI	Front End Serial Data Input.
FESO	Front End Serial Data Output.
FEPEN	Front End Paddles Enable.
FELEN	Front End Leads Enable.
FESCLKI	Front End Serial Clock Input.
FECHPCLK	Front End Chip Clock. Clock supplied to the ECG ASIC (2.048 MHz).
FE5V	5V to front end board.
FEPWRCLK	Front End Power Clock. The switching frequency of the front end power supplies (32 kHz).

Table H-4 **Control Board J3 to ECG Out Connector**

Pin	Signal
1	ECGSHIELD (connects to sleeve)
2	ECGOUT (connects to tip)
3	INSTATE (connects to ring)

Signal	Definition
ECGSHIELD	Connects to the shield of the ECG Out cable.
ECGOUT	ECG Out signal; 1V/1mV of the monitored source.
INSTATE	Instrument State. Indicates leads status: 0V = Off; 1.5V = On and Leads Off; 5V = On and Leads On.

Table H-5 **Control Board J4 to QRS Volume Control**

Pin	Signal
1	GROUND (connects to ground)
2	QRSCNTL (connects to wiper)

Signal	Definition
QRSCNTL	Used to set the volume level of the QRS tone.

Table H-6 **Control Board J5 to Defibrillator Connector J1**

Pin	Signal
1	nPADCHG
2	nDISCHGA
3	CHDONELED
4	GND
5	PAD5V
6	CGND
7	PCIDRV
8	nDISCHGS

NOTE

Each pin on the control board J5 connects to a pin with the same number on the defibrillator connector J1.

Signal	Definition
nPADCHG	Paddles Charge. Signal generated by the paddles charge button—active low. Initiates a charge operation.

Signal	Definition
nDISCHGA	Discharge Apex. A signal asserted when the apex paddle shock button is pressed.
CHDONELED	This signal is used for paddle type identification and it lights the Charge Done LED in the apex paddle.
PAD5V	5V supply for the paddles.
PCIDRV	This signal drives the PCI LED bar graph on the sternum paddle.
nDISCHGS	Discharge Sternum. A signal asserted when the sternum paddle shock button in pressed.

Table H-7 **Control Board J6 to Keypanel Board A1**

Pin	Signal	Pin	Signal
1	GND	14	CHDLED
2	nCHARGEKEY	15	HWID
3	nSYNCDEFIB	16	nPTAKEY
4	nPRINTSTOP	17	SYNCLED
5	nMARKEY	18	nHISTKEY
6	nLEADSKEY	19	CGROUND
7	nREVIEWKEY	20	N/C
8	nALARMKEY	21	ENSEL(0)
9	nACONLED	22	ENSEL(1)
10	BCHGLED	23	ENSEL(2)
11	GND	24	ENSEL(3)
12	nECGINC	25	nON
13	nECGDEC	26	GND

NOTE

Each pin on the control board J6 connects to a pin with the same number on the keypanel board a1.

Signal	Definition
nCHARGE KEY	A signal generated by the (Charge) key on the keypanel—active low. Initiates a charge operation.
nSYNCDEFIB	A signal generated by the (Sync) key on the keypanel—active low. Toggles between sync and defib operation modes.
nPRINTSTOP	A signal generated by the (Record) key—active low. Starts and stops the recorder.
nMARKEY	A signal generated by the (Mark) key—active low. Prints a mark.
nLEADSKEY	A signal generated by the (Lead Select) key—active low. Selects the active lead.
nREVIEW KEY	A signal generated by the (● Review) key—active low. Left side of key.
nALARMKEY	A signal generated by the (HR Alarm) key—active low. Controls HR Alarm functions.
nACONLED	AC On LED. Lights when unit is plugged into AC power.
BCHGLED	Battery Charge LED. Lights when unit is plugged into AC power and battery is installed.
nECGINC	A signal generated by the (▼ ECG Size) key—active low. Left side of key.
nECGDEC	A signal generated by the (ECG Size▲) key—active low. Right side of key.
CHDLED	Charge Done LED. Lights the Charge Done LED in the apex paddle.
nPTAKEY	Reserved.
SYNCLED	This signal lights the (Sync) LED when the unit is in sync mode. Asserted high.

Signal	Definition
nHISTKEY	A signal generated by the Review ● key—active low. Right side of ● Review ● key.
ENSEL(0), (1), (2), (3)	Energy Select. Four key bits set by the Energy Select control, which selects the charge level.
nON	This signal turns the instrument on—asserted low.

Table H-8 **Control Board J7 to Pacer Board J1**

Pin	Signal
1	PACEN
2	PACCUR
3	PACMES
4	GROUND
5	PACSYNCLK
6	HCVDC
7	HCRET

NOTE

Each pin on the control board J7 connects to a pin with the same number on the pacer board J1.

Signal	Definition
PACEN	Pacer Enable. Enables power to the pacer.
PACCUR	Pacer Current. Sets pacer output current.
PACMES	Pacer Measurement. Output current measured by the pacer and returned to the defibrillator controller.
PACSYNCLK	Pacer Synchronous Clock. Synchronizes the pacer switching power supply to an even multiple of the ECG sample rate (96 kHz).
HCVDC	High Current VDC (VDC+). Supplies primary power to the pacer.
HCRET	High Current Return (VDC–). Return for HCVDC.

Table H-9 **Control Board J8 to Power Supply Board J2B**

Pin	Signal	Pin	Signal
1	HCRET	9	nPSON
2	PRN12V	10	VDC2
3	GROUND	11	SWADRIVE
4	12V	12	HCVDC
5	5V	13	HCRET
6	GND	14	HCVDC

Table H-9 **Control Board J8 to Power Supply Board J2B**

Pin	Signal	Pin	Signal
7	PSSYNCLK	15	HCRET
8	ACON		

NOTE

Each pin on the control board J8 connects to a pin with the same number on the power supply board J2B.

Signal	Definition
HCRET	Dedicated return lines for HCVDC.
PRN12V	Recorder 12 volt supply. Powers the stepper motor.
PSSYNCLK	Power supply synchronizing clock (96 kHz).
ACON	Indicates that the supply is plugged into AC power.
nPSON	Active low. Enables the DC/DC converter (+5V and +12V).
VDC2	A more filtered version of VDC for use in powering up start-up logic and static RAM. ORed with VBATT to form VBACKUP.
SWADRIVE	Controls Switch A; when asserted (high), switch A is closed.
HCVDC	High current VDC supply for recorder and pacer.
HCRET	High current return lines for HCVDC.

Table H-10 **Control Board J9 to High Voltage Board J2**

Pin	Signal	Pin	Signal
1	HVDISCH	8	QUALACON
2	DEFBSTAT	9	VCAP
3	SSRY	10	AGROUND
4	nCHGEN	11	VBATT
5	AGROUND	12	PRDRV
6	AGROUND	13	nBATPRES
7	OPNSFRLY	14	CHRATE

NOTE

Each pin on the control board J9 connects to a pin with the same number on the high voltage board J2.

Signal	Definition
HVDISCH	High Voltage Discharge. Logical NOR of nDICCH and nDISCHS.
DEFBSTAT	Defibrillator Status. A signal generated by the high voltage board to provide patient relay status.
SSRY	Reserved.
nCHGEN	Charge Enable. A signal asserted by the system gate array to initiate a charge cycle. Used in conjunction with CHRATE.
OPNSFRLY	Open Safety Relay. A signal asserted by the system gate array which removes the 47 kΩ safety resistor which is normally across the HV capacitor.
QUALACON	AC On logic signal which is active only when +5V is present.
VCAP	Voltage CAPacitor. The capacitor voltage that is sampled to monitor the energy present across the HV capacitor.
VBATT	Battery voltage.
PRDRV	Asserted by the system gate array to close patient relay, connecting the patient to the high voltage capacitor. Qualified with HVDISCH on the HV board.
nBATPRES	Battery Present signal. When battery is installed, this line is low.
CHRATE	Charge Rate. An analog signal used to set the charge rate. Used with CHGEN to initiate a charge cycle.

Table H-11 **Control Board J10 to Patient Inductor**

Pin	Signal
1	IPEAK5V
2	IPEAK

Signal	Definition
IPEAK5V	5 volt supply to the IPeak transformer.
IPEAK	IPeak measurement signal from the IPeak transformer.

Table H-12 **Control Board J11 to CRT Deflection Board J1**

Pin	Signal
1	GND
2	VSYNC
3	GND
4	FBVIDEO
5	GND
6	HBVIDEO
7	GND
8	HSYNC
9	CRT12V
10	CRT12V

NOTE

Each pin on the control board J11 connects to a pin with the same number on the CRT deflection board J1.

Signal	Definition
VSYNC	Vertical Sync signal.
FBVIDEO	Full Bright Video signal.
HBVIDEO	Half Bright Video signal.
HSYNC	Horizontal Sync signal.
CRT12V	12 volt supply for the CRT.

Table H-13 **Control Board J12 to SpO_2 Board P1**

Pin	Signal	Pin	Signal
1	GND	18	nMWR
2	OAD(0)	19	GND
3	OAD(1)	20	CGND
4	GND	21	GND
5	OAD(2)	22	nOPTRDY
6	OAD(3)	23	GND
7	GND	24	nOPTINT0
8	OAD(4)	25	nOPTINT1
9	OAD(5)	26	nOPTINT2
10	GND	27	+DIGBACKUP
11	OAD(6)	28	nOPTSEL0
12	OAD(7)	29	+5V
13	GND	30	nOPTSEL1
14	OMALE	31	+12V
15	GND	32	nOPTSEL2
16	nMRD	33	nERAWRST
17	GND	34	nPRST

NOTE

Each pin on the control board J12 connects to a pin with the same number on the SpO_2 board P1.

Signal	Definition
OAD(0), (1), (2), (3), (4), (5), (6), (7)	Monitor address data bus lower 8 bits.
OMALE	Monitor Address Latch Enable.
nMRD	Monitor Read Strobe.
nMWR	Monitor Write Strobe.
nOPTRDY	Option Ready Signal.

Signal	Definition
nOPTINT0, nOPTINT1, nOPTINT2	Interrupt signals from options 0, 1, and 2.
+DIGBACKUP	DIGital BACKUP. A 4.3V low current regulated supply for powering battery backed-up logic on the SpO_2 board.
nOPTSEL0, nOPTSEL1, nOPTSEL2	Option Select.
nERAWRST	Raw Reset. A reset signal from the control board to the option slot.
nPRST	Reset. A monitor processor-controlled reset signal.

Table H-14 **Control Board J13 to Recorder Interface Board J1**

Pin	Signal	Pin	Signal
1	PRN12V	14	nPHLAT
2	HCRET	15	nPAPOUT
3	PRN12V	16	TSENSE
4	HCRET	17	SWPRNVDC
5	MTRPH0	18	HCRET
6	MTRPH1	19	SWPRNVDC
7	MTRPH2	20	HCRET
8	MTRPH3	21	SWPRNVDC
9	PRN5V	22	HCRET
10	GND	23	SWPRNVDC
11	PCLK	24	HCRET
12	PDATA	25	CAL
13	nPHSTB	26	CGND

NOTE

Each pin on the control board J13 connects to a pin with the same number on the recorder interface board J1.

Signal	Definition
PRN12V	Printer +12 volts. Used to power the stepper motor.
HCRET	High Current Return.
MTRPH0, 1, 2, 3	Stepper motor phase 0,1,2,3.
PRN5V	Supplies logic power to the recorder.
PCLK	Printer clock. Clocks data to the printhead.
PDATA	Printer data.
nPHSTB	Printhead Strobe. Enables the printhead dot printing. Duration of the strobe is controlled to compensate for printhead temperature and voltage.
nPHLAT	Printhead latch. Latches a column data of data into the printhead.
nPAPOUT	Paper Out. Conditioned signal that indicates the paper out condition.

Signal	Definition
TSENSE	Temperature SENSE. An analog signal generated by a temperature sensor on the recorder; varies the duty cycle for the printhead write.
SWPRNVDC	Switched printer VDC. A switched version of the VDC supply.
CAL	A voltage that encodes the printhead resistance; used to set the duty cycle for printhead writes.

Front End Board

These tables list the pin assignments for the connectors on the front end board. The connectors and the assemblies they connect to are listed in Table H-15; other tables list connector pin assignments.

Table H-15 Front End Board Connections

Front End Connector	Via Cable Assembly	Connects To	Reference
J1	M1722-61615	ECG In connector (8-pin)	Table H-16
J1	M1722-61614	ECG In connector (6-pin, option J02)	Table H-17
J1	M1722-61616	ECG In connector (12-pin, option J03)	Table H-18
J2	M1722-61611	Control board	Table H-3
J61	p/o M1722-82806	Defibrillator connector and patient relay	Table H-19
J62	p/o M1722-82806	Defibrillator connector and patient relay	Table H-19
J63	p/o M1722-60010	50–ohm load	Table H-19
J66	p/o M1722-60170	Pacer board	Table H-19

Table H-16 **Front End Board J1 to ECG In Connector (8-pin ECG)**

Front End Board J1		ECG In Connector	
Pin	**Signal**	**Pin**	**Signal**
1	LREF	4	Shield
2	RA	1	RA
3	LL	7	LL
4	LA	2	LA
5	V	6	Chest (5 wire)
6	RL	8	RL (5 wire)
7	LREF (Cable Shield)		

Table H-17 **Front End Board J1 to ECG In Connector (6-pin ECG)**

Front End Board J1		ECG In Connector	
Pin	**Signal**	**Pin**	**Signal**
1	Cable Shield	N/C	Shield
2	RA	A	RA
3	LL	C	LL
4	LA	B	LA
5	V	D	Chest (5 wire)
6	RL	E	RL (5 wire)
7	LREF	F	LREF

Table H-18 **Front End Board J1 to ECG In Connector (12-pin ECG)**

Front End Board J1		ECG In Connector	
Pin	**Signal**	**Pin**	**Signal**
1	cable Shield	N/C	Shield
2	RA	2	RA
3	LL	5	LL
4	LA	7	LA
5	V	6	Chest (5 wire)
6	RL	1	RL (5 wire)
7	LREF	C	LREF

Signal	Definition
RA	Right Arm.
LL	Left Leg.
LA	Left Arm.
V	Chest
RL	Right Leg.

Table H-19 **Front End Board J61, J62, J63, J65, J66**

Front End Board		Connects To
Pin	**Signal**	
J61A	STERNUM-1 (HV RED)	Defibrillator connector, J1-S, HI VOLTAGE—STERNUM
J61B	STERNUM-2 (HV RED)	Patient relay, OUTPUT + (COMMON 1)
J62A	APEX-1 (HV WHITE)	Defibrillator connector, J1-A, HI VOLTAGE—APEX
J62B	APEX-2 (HV WHITE)	Patient relay, OUTPUT - (N.O. 2)
J63	PADINPOCKETS (HV BLACK)	50–ohm load, TAP (paddles in pocket detection)
J66	PACER (HV WHITE)	Pacer board, P51, PACER RETURN (HV WHITE)

ECG Out Connector

The ECG Out connector connects to J3 on the control board. See Table H-4 for pin assignments.

QRS Volume Control

The QRS volume control connects to J4 on the control board. See Table H-5 for pin assignments.

Defibrillator Connector

The defibrillator connector connects to the control board and the front end board. Table H-20 lists connector pin assignments.

Table H-20 Defibrillator Connector J1

From Defibrillator Connector		To Control Board	
Pin	**Signal**	**Pin**	**Signal**
1	nCHARGE	1	nPADCHG
2	CHDONE/PADID	2	nDISCHGA
3	+5V	3	CHDONELED
4	PCI	4	GND
5	nDISCHARGE APEX	5	PADS5V
6	LOGIC GND	6	CGND
7	SHIELD GND	7	PCIDRV
8	nDISCHARGESTERNUM	8	nDISCHGS
From Defibrillator Connector		**To Front End Board**	
A	HI VOLTAGE - APEX	J62A (HV WHITE)	APEX-1
S	HI VOLTAGE - STERNUM	J61A (HV RED)	STERNUM-1

Signal	Definition
nCHARGE	Apex paddle charge button. Charge is asserted low.
CHDONE/ PADID	Voltage level indicates the type of paddles connected to the instrument. Also used to light the apex paddle charge done LED.
PCI	Patient contact impedance. A voltage which turns on a specific number of LEDs on the sternum PCI LED bar.
nDISCHARGE APEX	A signal asserted when the apex paddle shock button is pressed.
nDISCHARGE STERNUM	A signal asserted when the sternum paddle shock button is pressed.
HI VOLTAGE - APEX	Connects the apex paddle (pad) to the output (-) side of the patient (transfer) relay and to pacer (-) terminal (if the pacer is installed).
HI VOLTAGE - STERNUM	Connects the sternum paddle (pad) to the output (+) side of the patient (transfer) relay and to the pacer (+) terminal if the pacer is installed.

Keypanel Board

These tables list the pin assignments for the connectors on the keypanel board. The connectors and the assemblies they connect to are listed in Table H-21; Table H-22 lists connector pin assignments for J1.

Table H-21 Keypanel Board Connections

Keypanel Board Connector	Via Cable Assembly	Connects To	Reference
A1	p/o M1722-60195	Control board, J6	Table H-7
J2	M1722-61900	Energy Select switch	Table H-22
J3	M1722-61652	SpO_2 board, P2	Table H-23

Table H-22 Keypanel Board J2 to Energy Select Switch

Pin	Signal
1	N/C
2	ENSEL(3)
3	GND
4	ENSEL(2)
5	nON
6	ENSEL(1)
7	ENSEL(0)
8	N/C

Signal	Definition
ENSEL(0), (1), (2), (3)	ENergy SELect. Four key bits set by the Energy Select control, which selects the charge level, or the monitor on position.
nON	Asserted low on all switch positions except the standby position. Turns the instrument on.

Table H-23 **Keypanel Board J3 to SpO_2 Board P2**

Pin	Signal
1	nONOFFKEY
2	nALRMKEY

Signal	Definition
nONOFFKEY	SpO_2 On/Off key
nALRMKEY	SpO_2 Alarm key

Pacer Keypanel Board

The pacer keypanel board J1 connects to the control board, J1. See Table H-2 for pin assignments.

Pacer Board

These tables list the pin assignments for the connectors on the pacer board. The connectors and the assemblies they connect to are listed in Table H-24; Table H-25 lists connector pin assignments for J51 and P51.

Table H-24 **Pacer Board Connections**

Pacer Board Connector	Via Cable Assembly or Wire	Connects To	Reference
J1	M1722-61617	Control board, J7	Table H-8
J51	HV RED	Patient relay (isolated)	Table H-25
P51	HV WHITE	Front end board (Isolated)	Table H-25

Table H-25 **Pacer Board J51, P51**

Pin	Signal	Connection	Signal
J51	PACER +	Patient relay, (N.C. 1)	+ PACER
P51	PACER RTN (WHITE HV WIRE)	Front end board, J66	PACER

Signal	Definition
PACER +	Positive polarity of pacer output.
PACER RTN	Pacer output return.

Power Supply Board

These tables list the pin assignments for the connectors on the power supply board. The connectors and the assemblies they connect to are listed in Table H-26; Table H-27 and Table H-28 list connector pin assignments for J2A and J2B.

Table H-26 **Power Supply Board Connections**

Power Supply Connector	Via Cable Assembly	Connects To	Reference
J1	M1722-61607	AC input cable	Table H-27
J2A	M1722-61606	High voltage board, J1	Table H-28
J2B	M1722-61606	Control board, J8	Table H-9

Table H-27 **Power Supply J1 to AC Input Cable**

Pin	Signal
1	LOW LINE (BROWN)
2	IMAGE PLANE (Cable shield); also connects to VDC RETN, GROUND, and YCAPS.
3	HIGH LINE (BLUE)

NOTE

A green/yellow wire from the AC line module connects to the IEC ground lug on the defibrillator rear panel.

Table H-28 **Power Supply J2A to High Voltage Board J1**

Power Supply Board J2A		High Voltage Board J1	
Pin	**Signal**	**Pin**	**Signal**
6	+12R	10	+12B
7	+12R RTN	9	AGROUND
8	VBATT	8	VBATT
9	VBATT	7	VBATT
10	GROUND	6	AGROUND
11	VBATT	5	VBATT
12	VDC	4	VDC
13	VDC RTN	3	AGROUND
14	VDC	2	VDC
15	VDC	1	VDC

NOTE J2A, pins 1 through 5 are not used.

Signal	Definition
12R	12 volt supply
12R RTN	12 volt supply return.
VBATT	Battery voltage
VDC	AC/DC converter voltage

High Voltage Board

These tables list the pin assignments for the connectors on the high voltage board. The connectors and the assemblies they connect to are listed in Table H-29; Table H-30 and Table H-31 list connector pin assignments.

Table H-29 **High Voltage Board Connections**

High Voltage Board	Via Cable Assembly	Connects To	Reference
J1	M1722-61606	Power supply board, J2A	Table H-28
J2	M1722-61610	Control board, J9	Table H-10
J3		HV capacitor and Patient inductor	Table H-30
J5		Patient relay	Table H-30
J6		HV capacitor and patient relay	Table H-30
J8		Patient relay	Table H-30
	p/o M1722-60110	Battery board	Table H-31

Table H-30 **High Voltage Board J3, J5, J6, J8**

Pin	Signal	Connects To
J3-1	HV CAP+	HV capacitor, +HV CAP (RED HV; P/O 0160-7577)
J3-2	HV IND IN	Patient inductor, INDUCTOR IN (RED; P/O M1722-82800)
J5-1	VDC	Patient relay, + PRELAY DRIVE (P/O M1722-82806)
J5-2	AGROUND	Patient relay, GROUND
J5-3	RELAYRTN	Patient relay, - PRELAY DRIVE
J6-1	HV CAP -	HV capacitor, - HV CAP (WHITE HV; P/O 0160-7577)
J6-2	PR COM 2	Patient relay, - HV CAP (COMMON 2) (P/O M1722-82806)
J8	PR N.C. -2	Patient relay, - CHARGER (N.C. 2) (P/O M1722-82806)

Signal	Definition
HV CAP+	Positive terminal of the high voltage capacitor; flying lead terminated by a 0.187 female faston.

Signal	Definition
HV IND IN	Input side of the waveshaping inductor.
VDC	AC/DC converter voltage.
RELAYRTN	Relay Return.
HV CAP -	Negative lead of HV capacitor; flying lead terminated by a 0.187 female faston.
PR COM 2	Patient Relay, Common 2.
PR N.C. 2	Patient Relay, Normally Closed 2.

Table H-31 High Voltage Board to Battery Board

Signal	Via Cable Assembly	Connects To
nBATPRES	Blue	Battery board, BAT-SENS
VBATT	Red	Battery board, BAT+FUSE
AGROUND	Black	Battery board, BAT–

Signal	Definition
nBATPRES	Asserted low when a battery is connected.
VBATT	Fused battery voltage.
AGROUND	Return path for battery voltage.

Patient Inductor

These tables list the pin assignments for the connectors on the patient inductor. The connections are listed in Table H-32.

Table H-32 Patient Inductor

Patient Inductor	Connects To
IPEAK +5V	Control board, J10-1, IPEAK5V
IPEAK	Control board, J10-2, IPEAK
INDUCTOR IN (RED)	High voltage board, J3-2, HV INDUCTOR IN
INDUCTOR OUT (RED)	Patient relay, +HV CAP (N.O. 1) (RED)

Signal	Definition
IPEAK +5V	Supply for Ipeak transformer measurement.
IPEAK	Ipeak transformer output (used by Ipeak measurement circuitry.
INDUCTOR IN	Input side (H.V capacitor) of waveshaping inductor.
INDUCTOR OUT	Output side (patient) of waveshaping inductor.

CRT Deflection Board

On the CRT deflection board, J1 connects to J11 on the control board. The pin assignments are the same on both connectors. See Table H-12 for pin assignments.

Table H-33 CRT Deflection Board Connections

CRT Deflection Board Connector	Connects To	Reference
J1	Control board, J11	Table H-12
J2	CRT Deflection yoke	Table H-34

Table H-33 **CRT Deflection Board Connections**

CRT Deflection Board Connector	Connects To	Reference
J3	CRT Socket board	Table H-35
J4	CRT Socket board	Table H-36

NOTE

The CRT socket board J5 connects to J5 on the CRT tube socket.

Table H-34 **CRT Deflection Board J2 to CRT Deflection Yoke**

Pin	Signal
1	VCOILRET (BLUE)
2	VCOILOUT (RED)
3	GND (BLACK)
4	HCOILOUT (GREEN)
5	HCOILRET (YELLOW)

NOTE

Each pin on the CRT deflection board J2 connects to a pin with the same number on the CRT deflection yoke, as shown in Table H-34.

Signal	Definition
VCOILRET	Vertical deflection coil return.
VCOILOUT	Vertical deflection coil drive.
HCOILOUT	Horizontal deflection coil drive.
HCOILRET	Vertical deflection coil return.
GND	Tied to DAG ground of CRT, through single screw attaching PC board to CRT frame.

Table H-35 **CRT Deflection Board J3 to CRT Socket Board J5**

CRT Deflection Board J3		CRT Socket J5
Pin	**Signal**	**Pin**
J3-1	GND	J5-3
J3-2	VIDEOOUT	J5-2
J3-3	GND	J5-3
J3-4	+12V	J5-4

Signal	Definition
VIDEOOUT	Video control voltage: +28V = dot off, +4.3V = half bright, 0.0V full bright.
12V	12 volt supply
GND	Ground

Table H-36 **CRT Deflection Board J4 to CRT Socket Board J5**

CRT Deflection Board J4		CRT Socket J5
Pin	**Signal**	**Pin**
J4-1	INTENS	J5-1
J4-2	GRID-2	J5-6
J4-3	FOCUS	J5-7

Signal	Definition
INTENS	Display intensity (adjustable: -3.9V to 0.0V)
GRID-2	CRT Grid bias voltage (adjustable: 0V to +200 V

SpO_2 Board

On the SpO_2 board, P1 connects to J12 on the control board. The pin assignments are the same on both connectors. See Table H-13 for pin assignments. Table H-37 lists connections on the SpO_2 board.

Table H-37 SpO_2 Board Connections

SpO_2 Board	Via Cable Assembly	Connects To	Reference
P1	M1722-61628	Control board, J12	Table H-13
P2	M1722-61651	Front keypanel board	Table H-23
P101	M1722-61651	SpO_2 input connector	Table H-38

Table H-38 SpO_2 Board to SpO_2 Input Connector

SpO_2 Board		SpO2 Input Connector	
Pin	Signal	Pin	Signal
1	SIGNAL	1	SIGNAL
2	FGND	A	FGND
3	REXT1	3	REXT1
4	REXT2	5	REXT2
5	LEDSENCE	6	LEDSENSE
6	LEDDR	7	LEDDR
7	FGND	2	FGND

SIGNAL Received optical current.

FGND SpO_2 isolated ground.

REXT1 Cable coding resistor #1.

REXT2 Cable coding resistor #2.

LEDSENCE Detected current through LEDs.

LEDDR Drive current for LEDs.

Recorder Interface Board

On the recorder interface board, J1 connects to J13 on the control board. The pin assignments are the same on both connectors. See Table H-14 for pin assignments.

Battery Board

Table H-39 lists connections on the battery board.

Table H-39 Battery Board Connections

Battery Board	Via Cable Assembly	Connects To	Reference
	p/o M1722-60110	High voltage board	Table H-31
J4		Battery assembly, J1	Table H-40

Table H-40 Battery Board J4 to Battery Assembly J1

Pin	Signal
1	BAT+
2	BAT+
3	BAT+SLOW
4	BAT-SENS
5	BAT-
6	BAT-

NOTE

Each pin on the battery board J4 connects to a pin with the same number on the battery assembly.

Signal	Definition
BAT+	Positive terminal of battery.
BAT+SLOW	Connection first made by the long pin in the battery connector; limits current when initially charging capacitance on the VBATT line.
BAT-SENS	Battery Sense.
BAT–	Battery return. Connects to negative terminal of battery.

Battery Assembly

The battery assembly connects to the J4 on the battery board. See Table H-40 for pin assignments.

HV Capacitor

The HV capacitor connects to the high voltage board, J3 and J6. See Table H-30 for pin assignments.

Patient Relay

Table H-41 lists the connection points for the patient relay.

Table H-41 **Patient Relay**

Patient Relay	Connects To
- CHARGER (N.C. 2)	High voltage board, J8
+ HV CAP (N.O. 1)	Patient inductor, INDUCTOR OUT
- HV CAP (COMMON 2)	High voltage board, J6-2
+ PRELAY DRIVE	High voltage board, J5-1
GROUND	High voltage board, J5-2
- PRELAY DRIVE	High voltage board, J5-3
+ PACER (N.C. 1)	Pacer board, J51
OUTPUT + (COMMON 1)	Front end board, J61B
OUTPUT - (N.O. 2)	Front end board, J62B

50-Ohm Load Assembly

The 50-ohm load assembly connects to J63 on the front end board. See Table H-19 for pin assignment. In addition, the TO STERNUM point on the assembly connects to the sternum paddle pocket; the TO APEX point on the assembly connects to the apex paddle pocket.

ECG In Connector

The ECG In connector connects to J1 on the front end board. See Table H-16 for pin assignments.

AC Line Module

The AC line module connects to J1 on the power supply board. See Table H-27 for pin assignments. In addition, the GROUND connection on the AC line module goes through a green/yellow wire to the IEC ground lug.

Energy Select Switch

The Energy Select switch connects to J2 on the keypanel board. See Table H-22 for pin assignments.

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